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Significance of Analytic and Reflective Attitudes

By

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Psychological Monographs: General and Applied

INFORMATION PROCESSING IN THE CHILD:
SIGNIFICANCE OF ANALYTIC AND REFLECTIVE ATTITUDES[1]

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A series of studies with children in Grades 1–4 inquired into the immediate and historical determinants of a preference for analytic conceptual groupings. An analytic concept is based upon shared similarity in a particular objective component among a set of stimuli (e.g., animals with 1 ear, people with hats on). Results revealed that 2 more fundamental cognitive dispositions each contributed variance to the production of analytic concepts: the tendency to reflect over alternative solutions or classifications in situations in which several response alternatives are available simultaneously, and the tendency to analyze visual arrays into their component parts. These 2 dispositions are relatively independent of each other, orthogonal to verbal skills; and each influences the frequency of errors in perceptual recognition tasks. Degree of reflection over alternative solution hypotheses (as measured by response time) displayed remarkable generality across a variety of tasks and marked intraindividual stability over a 1-yr. period. There was an inverse relation between the production of analytic concepts and extreme degrees of hyperactivity and distractibility contemporaneously as well as during the 1st 8 yr. of life.

PROBLEM solving involves at least three distinct processes that occur in the following sequence: the initial categorization of information, storage of the encoded information, and the imposing of transformations or mediational elaborations upon the encoded material. The form of the initial categorization, transformation, or mediation is governed, of course, by the nature of the problem. Students of cognitive development have generally assumed that the striking differences between the cognitive products of children of different ages (or among children of the same age) were due primarily to differences in the availability of a classification vocabulary, transformation rules, and mediational diversity. In effect, the superior problem solving performance of older, in contrast to younger, children has been assumed to result from the richer knowledge repertoire of the older children. This supposition is intuitively attractive and empirically verified. It is not surprising, therefore, that psychologists have not seriously entertained the possibility that other factors may contribute to age and individual differences in cognitive products. Specifically, there has been a tendency to neglect the relevance of individual differences in the processing of information—differences in the aspects of stimuli that are initially selected for labeling and the degree of reflection attendant upon classification of events or the selection of solution hypotheses. For children and adults have a clear preference hierarchy with respect to the stimulus characteristics to which they initially attend and the speed with which classification decisions are made.

The classical dimension of analytic versus global categorizations describes a stimulus processing variable. The tendency to analyze a stimulus into its differentiated components increases with age, and at any single age there are stable individual differences in this tendency (Wohlwill, 1960). The notion of a generalized disposition to analyze external experience is not a new one. Early investigators in psychophysics noted that "analytic" subjects produced more sensitive threshold values than "synthetic" subjects. More recently, Witkin, Lewis, Hertzman, Machover, Meissner, and Wapner (1954) and Witkin, Dyk, Faterson, Goodenough, and Karp (1962) have used the phrases *analytic* and *field independent* in somewhat similar ways and have demonstrated that the tendency to analyze complex stimulus situations and detect patterns embedded in a distracting context increases with age and predicts basic behavioral characteristics of the individual.

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A central problem in discussing this dimension is the existence of markedly different sets of measurement operations, each of which has been labeled as an index of an analytic tendency. These varied test procedures are probably not assessing identical constructs, and it is necessary to restrict statements about analytic tendencies to the operations used in any particular study.

Analytic Concepts: Background Information

A series of investigations with school age children revealed that some children showed a clear preference to group familiar objects together on the basis of objective elements of similarity that were component parts of the total stimulus (Kagan, Moss, & Sigel, 1963). The technique used to measure this preference for analytic conceptualizations was a set of 30 cards, each with three black and white drawings of familiar objects (hereafter called the Conceptual Style Test or CST). Figure 1 illustrates some stimuli from this instrument.

The child was asked to "Pick out two pictures that are alike or go together in some way" and to state the basis for his grouping. These stimuli were constructed to elicit the two major concept classes of analytic and relational concepts, and, to a lesser degree, inferential-categorical concepts. An analytic concept involved pairings based on similarity

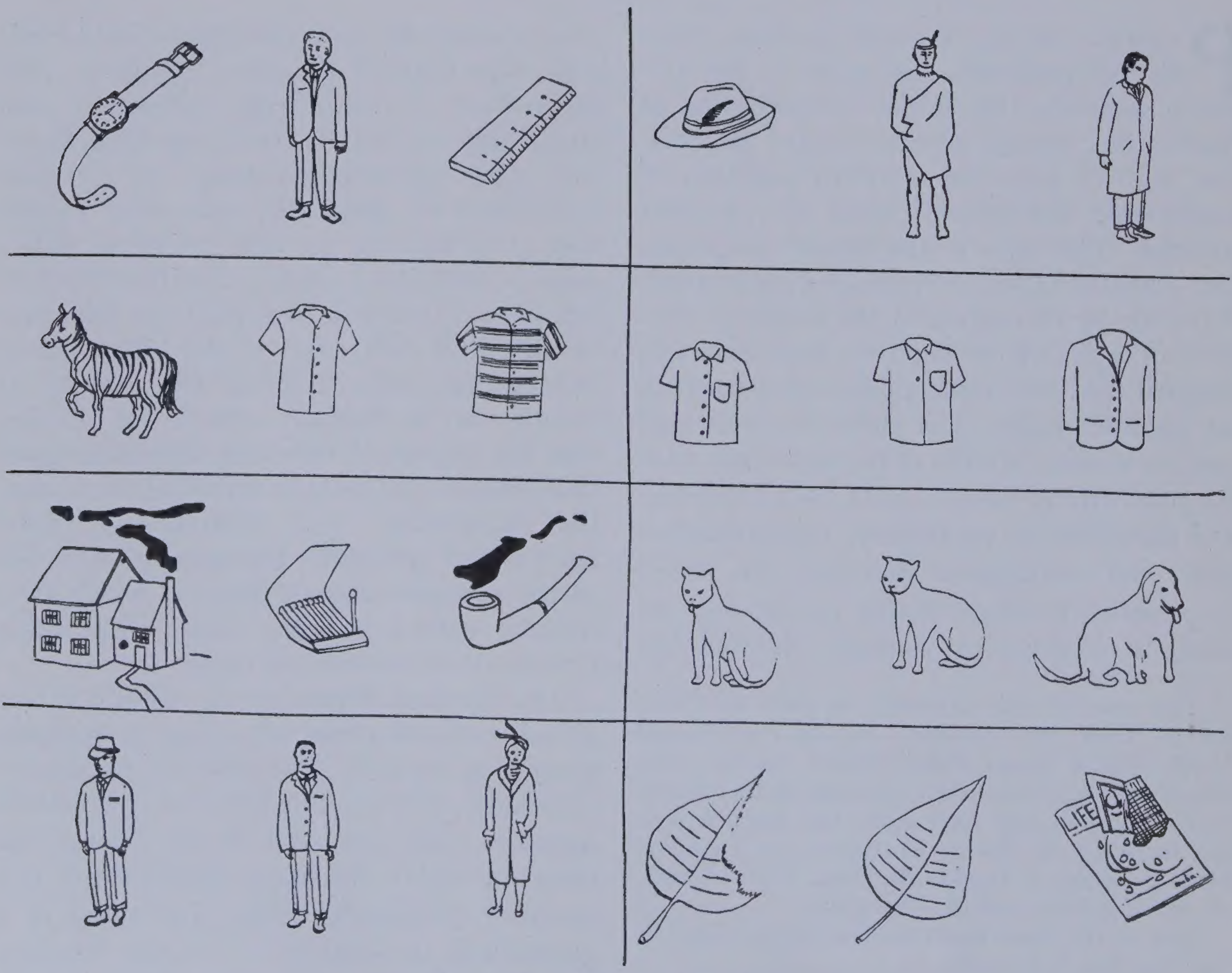

FIG. 1. Sample items from CST.

in an objective attribute that was a differentiated part of the total stimulus. Examples of this category are, "The watch and ruler have numbers," "The zebra and shirt have stripes," "The house and pipe have smoke coming out," "People with hats on," "Animals with their tongues out." The basis of similarity in each of these examples involves a component part of the total stimulus (e.g., numbers, stripes, smoke, hats, tongues). The relational category involved pairings based on a functional relationship between two stimuli. For these particular pictures, a functional relationship was an obvious association to the test item. Examples of relational concepts are, "The man wears the watch," "The matches light the pipe," "The hat goes on the man," "The dog and cat play together." The inferential-categorical class included conceptual pairings that were based on similarity in some inferred quality or involved a language convention. Examples of inferential concepts are "Inanimate objects," "Articles of clothing," "Human beings."

Earlier investigations indicated that the tendency to delay a conceptual decision was associated with the production of analytic concepts on CST (Kagan et al., 1963). The material in this monograph considerably extends the earlier studies. The data demonstrate the consistency of an analytic attitude across situations and suggest that the more fundamental processes of reflection versus impulsivity and visual analysis of complex arrays are primary determinants of the production of analytic concepts.

Developmental Changes in Analytic Concepts. CST has been administered to over 800 children in the elementary grades, and Figure 2 shows the linear increase in analytic responses with age. The data in Figure 2 are based on individual administration of CST with the exception of the Grade 4 data marked SMSG.[4]

First graders typically produced an average of about 4 analytic responses; sixth graders produced 9 to 10 analytic responses.

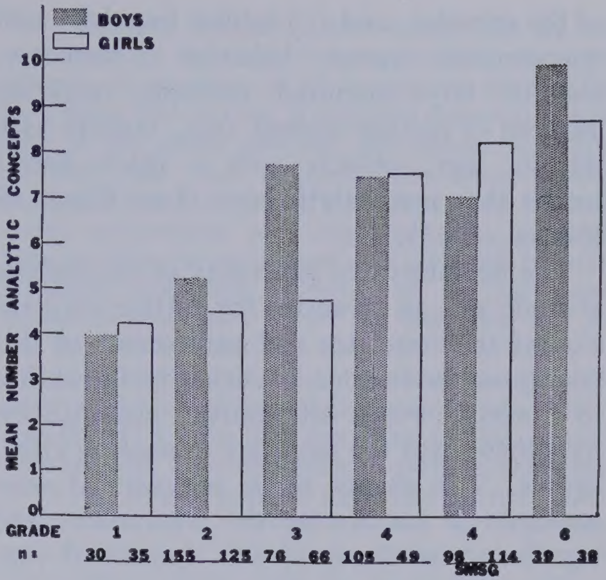

FIG. 2. Age changes in analytic concepts on CST.

Stability of an Analytic Attitude. The continuity of an analytic conceptual preference over a 12-month period was determined in three small samples. For one group of children tested in Grade 3 and then again in Grade 4, the coefficient was .70 for 24 girls and .43 for 22 boys. For another group of 35 boys tested first in Grade 4 and then in Grade 5, the coefficient was .73. Finally, for 52 boys originally tested in Grades 1 and 2 and retested in Grades 2 and 3, the stability coefficient was .47. There was, therefore, moderate stability over a 12-month period and increasing stability of an analytic attitude with age. The split-half reliability for this 30-item test was excellent. The corrected split-half reliability coefficient based on 300 protocols was .94.

Meaning of Analytic Concepts. Previous investigations (Kagan et al., 1963) indicated that children who were highly analytic on the 30-item CST, in comparison to nonanalytic children, were more likely to (*a*) produce interpretations of ink blots that were highly differentiated and contained references to descriptive aspects of the stimulus (e.g., butterfly with wings and feet) and produce fewer indistinct percepts (e.g., mud, cloud, paint), (*b*) attach a new verbal response to the component parts of a geometric design rather than only to the most salient aspect of the stimulus, and (*c*) inhibit impulsive and uncontrolled motor behavior. Moreover, analytic boys acquired concepts requiring analysis of picture stimuli (e.g., objects with missing legs; objects with a black band) earlier than nonanalytic boys (Lee, Kagan, & Rabson, 1963).

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[4] Grade 4 SMSG data came from a group administered procedure using a booklet of 16 pictures, and administered as part of the National Longitudinal Study of Mathematical Abilities, sponsored by the School Mathematics Study Group, directed by E. G. Begle of Stanford University.

The demonstrated generality of an analytic attitude was an incentive for further exploration of the correlates and antecedents of this conceptual preference, particularly the ability to reflect over alternative classification hypotheses and the tendency to analyze visual arrays. The studies to be summarized were attempts at uncovering the antecedents and significant correlates of this domain of conceptual behavior.

STUDY 1

This study assessed the relation between analytic concepts on CST and performance in three situations requiring analysis of complex visual patterns: (*a*) the ability to locate meaningful stimuli that were embedded in a context of interfering lines, (*b*) performance on special subtests of the Wechsler Intelligence Scale for Children (WISC), and (*c*) degree of articulation present in interpretations of ink blot stimuli. The second purpose was to attempt to replicate an earlier finding that analytic children were more likely than nonanalytic ones to respond to nouns and adjectives in a word association test with words that belonged to the same syntactic class as the stimulus. This tendency was not highly correlated with IQ or vocabulary score. One possible rationale for this result was that analytic children might be precocious in learning syntactic classes and in learning that nouns have something in common with other nouns. It is not completely fanciful to speculate (*a*) that the learning of syntactic equivalences involves an implicit analysis of speech, noticing that nouns appear first in sentences and are given vocal emphasis and (*b*) that adjectives like "hot" and "black" are often contrasted with their opposites "cold" and "white."

Procedure

Subjects. The subjects (*Ss*) were 62 boys (32 in Grade 1 and 30 in Grade 2), Caucasian, middle class, and of average intelligence. The age range for Grade 1 was 6-1 to 7-4 with a median of 6-9; for Grade 2 the range was 7-4 to 8-7 with a median of 7-9. Each *S* was seen on two separate occasions at the Institute by a female *E* (BLR), and 56 of the 62 subjects were seen for a third session with a male and female *E* present (BLR and JK).

Administration of Tests: Session I.

1. CST—The *E* said,

> I have some cards here with three pictures on them like this one. I want you to pick out two pictures that are alike or go together in some way. [After the child had selected two pictures *E* asked him] "Why did you pick these"?

The variable of primary interest was the number of analytic responses (i.e., a conceptual pairing based upon similarity in component parts).

2. Word-association test—In this test 40 words (20 singular nouns, 10 adjectives, and 10 verbs) were presented to each *S* with the following instructions.

> I am going to say a word out loud and you tell me the first word that comes into your mind as quickly as you can.

Response latency and the child's response were recorded. The child's meaningful associations fell into several major classes. Most of the responses to the nouns were (*a*) nouns in the same conceptual class as the stimulus, (*b*) verbs that were phrase completions to the nouns, or (*c*) nouns that were functionally related to the stimulus noun. Noun responses in the same conceptual class (called coordinate nouns) were either synonyms of the stimulus or words that shared membership in a conceptual class with the stimulus. There were, of course, noun responses that were neither synonyms nor instances of the same class (i.e., dog-fire, glass-car). The response CAT to the stimulus DOG was scored as a coordinate noun for both were members of the class ANIMAL or PET. The response MILK to GLASS was not scored as a coordinate noun because glass and milk have a functional relationship and are not independent instances of a superordinate category.

The response of major interest to adjectives was production of antonyms (e.g., dirty-clean, tall-small, hot-cold). The other categories that occurred were either nouns or synonyms. The responses to verbs were either verbs or nouns. The variable of major interest was a verb response that belonged to the same conceptual class as the stimulus verb (called *coordinate verbs,* e.g., throw-catch, run-walk, run-trot, write-draw, draw-paint, jump-stand, walk-sit).

The second grade boys produced significantly more coordinate noun, coordinate verb, and antonym responses than the first graders. The mean scores for the three categories were 8.2 versus 3.4, 3.6 versus 1.0, and 6.2 versus 1.8 ($p < .01$ for each comparison). Unless stated otherwise, all p values in this monograph are for two-tailed tests, and significance levels for mean differences are based on t tests. The year of development between Grades 1 and 2 is witness to a large increase in the tendency to produce word associates that match the syntactic class of a stimulus. Additional data on the frequency of coordinate nouns, verbs, and antonyms for 107 third and 52 fourth grade boys indicated little change in frequency of occurrence of these categories between these two ages. The means for the third and fourth grade *S*s were 9.8 versus 9.5 for coordinate nouns, 5.1 versus 5.6 for coordinate verbs, and 5.6 versus 5.4 for antonyms. The mean scores for Grades 3 and 4 were similar in magnitude and slightly higher (for nouns and verbs) than the scores for Grade 2 children. There is, therefore, a more significant shift in the syntactic character of word-association responses between Grades 1 and 2 than between Grades 2–3 or 3–4.

3. Hidden Figures Test (HFT)—HFT was devised especially for this study and consisted of one practice and 11 test items. Each item included a figure card that illustrated a familiar object (e.g., Mickey Mouse, a cowboy, a rose), and a hidden figure card in which the familiar object was embedded (i.e., blended into a patterned background). Sample items appear in Figure 3.

Administration. The *E* said, "Here is a picture. What is this?" On the rare occasion when the child did not respond correctly *E* said, "It is a——." Then the hidden figure card was placed in front of the child to the right of the figure card and *S* was told, "Now you find the —— in this picture. Point to the —— when you find it."

If *S* selected incorrectly, he was told that he had not found the figure and was encouraged to look for it again. A maximum of 60 seconds was allowed for each item. The number of incorrect guesses, response time to the correct selection, and success or failure on each item were recorded. The items differed markedly in difficulty, and a weighted score for each child's performance was computed using weighted solution times for each item. The odd-even intratest reliability coefficients, corrected by the Spearman-Brown formula, were .78 for the first grade and .41 for the second grade. A frequency distribution of solution times was constructed for each item for each grade, and each of the 11 distributions was divided into thirds. A score of 3 was given for the shortest solution time, 2 for the moderate solution times, and 1 for the longest solution times and failures. Each child was given a score of 1, 2, or 3 for each item, and *S*'s total score was the sum of the 11 item scores. The median solution times for the 11 items prior to weighting revealed that the second grade children solved these hidden figures significantly earlier than the first grade children (2.4 seconds versus 4.7 seconds; $p < .001$).

A second variable obtained from HFT was the number of incorrect solutions offered by the child. The child was allowed to offer solutions until he solved the item (or for a maximum of 60 seconds) and the range of scores on this variable was considerable.

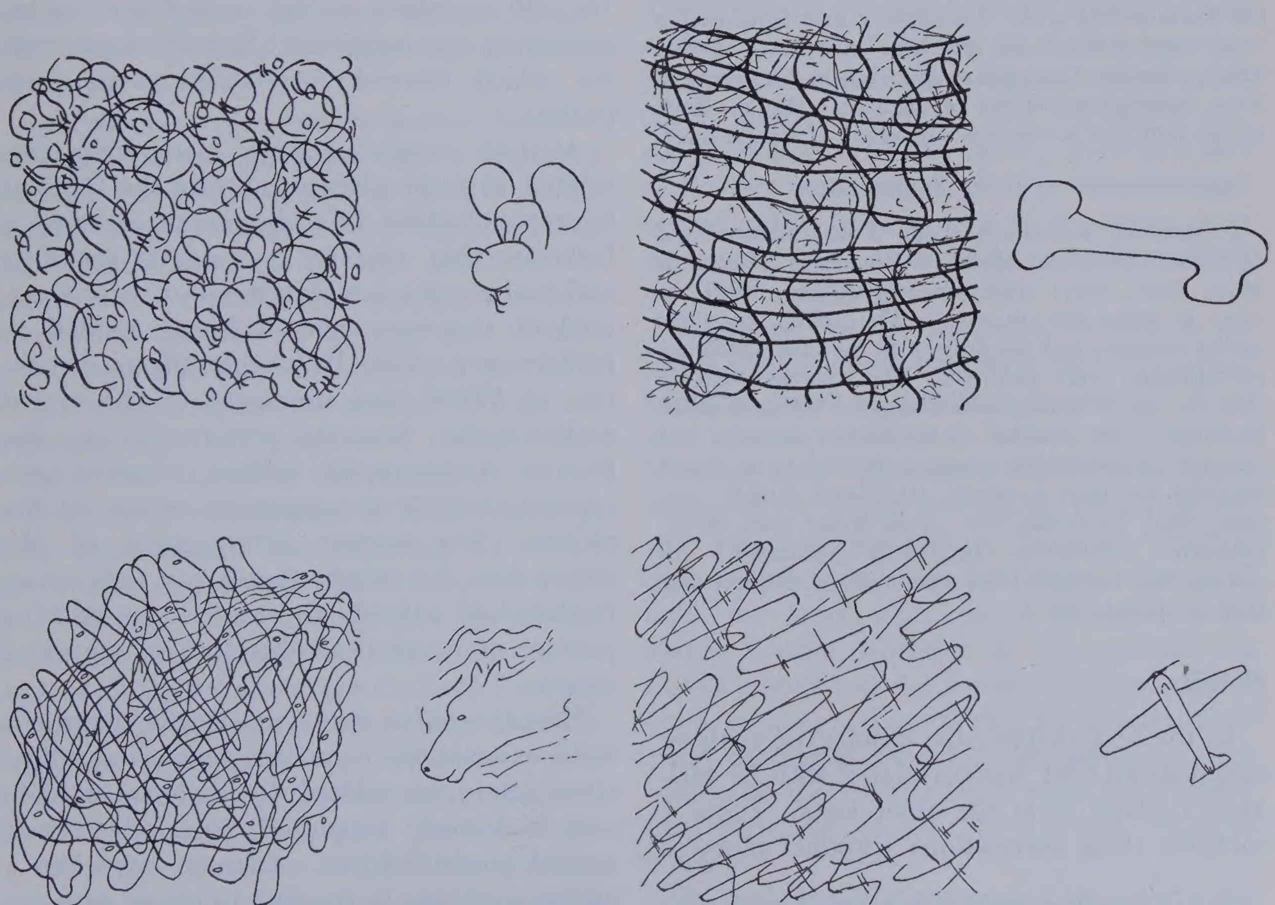

FIG. 3. Sample items from HFT.

Administration of Tests: Session II.

1. Paired-associate learning—The *S* learned four sets of four-word pairs. In each group of four-word pairs the stimulus words were nouns and the response word was either a verb, a coordinate noun, an adjective, or a noun that had a part-whole relationship to the stimulus noun. The four sets follow:

Set 1: Father-work, horse-chicken, ball-round, shirt-buttons
Set 2: Truck-wheels, knife-cuts, cup-glass, pear-yellow
Set 3: Bread-meat, pillow-soft, book-page, lion-roars
Set 4: Stick-long, bird-wing, rain-falls, pants-shoes

The *E* read each stimulus word and gave the child 10 seconds to answer. If no answer was forthcoming, *E* gave the child the correct answer. If *S* gave the wrong answer, *E* corrected him. The four words in a set were read to the child until he had mastered each set to a criterion of one correct trial (i.e., all four pairs in the set were correctly anticipated). This procedure was repeated until *S* had mastered all four sets. The variables scored were (*a*) the ease of learning each of the lists, and (*b*) differential difficulty in learning coordinate noun pairs when general learning ability was controlled statistically.

2. WISC—Four subtests of WISC were administered to *S*s, two from the Verbal scale and two from the Performance scale. Vocabulary and Information tests were selected as the best indexes of verbal ability; Picture Completion and Picture Arrangement were regarded as related to analytic attitude. Each of the four raw scores was converted to a scale score.

Administration of Tests: Session III.

1. Modified Rorschach—Each *S* was administered 16 stimuli from the Modified Rorschach (Kagan & Moss, 1961, 1962) with the instructions, "Tell me what it looks like to you." The child's complete verbal response and the latency to his first significant verbalization were recorded. The average reaction time for the 16 stimuli was computed for each child. In addition, the number of nondistinct percepts was assessed. A nondistinct response referred to an object that did not have a clearly articulated outline (e.g. mud, paint, ice cream, dirt, cloud, water, stuff, lava). Interrater reliabilities (percentage agreement) for scoring this variable from protocols of children age 6–16 averaged 90%.[5]

Results

In the first analysis the number of analytic responses on CST was correlated with 13 variables derived from the other tests. Table 1 contains these correlations (product moment for all variables except coordinate verbs, antonyms, and nondistinct Rorschach percepts for which biserial correlations were computed).

TABLE 1

RELATION BETWEEN ANALYTIC CONCEPTS AND OTHER VARIABLES

Variable	Grade 1	Grade 2
Word association		
Noun—coordinate noun	.31*	.61***
Verb—coordinate verb ($r_{\text{bis.}}$)	−.01	.38*
Adjective—antonym ($r_{\text{bis.}}$)	.47**	.42**
Mean response time	−.09	.01
Hidden figures		
Weighted speed	.34*	.58***
Paired-associate learning		
Total errors	−.12	−.29
Errors in learning coordinate nouns	.13	−.20
WISC		
Information	.29	.19
Vocabulary	.06	−.08
Picture Completion	.22	.37**
Picture Arrangement	.58***	.55***
Ink blots		
Mean response time	−.09	.01
Indistinct response ($r_{\text{bis.}}$)	.01	−.05

* $p < .10$, two tailed
** $p < .05$, two tailed.
*** $p < .01$, two tailed.

Analytic responses were moderately correlated with the ability to locate the familiar figures embedded in a distracting context, a behavior that required systematic scanning and analysis of a complex stimulus. Moreover, analytic concepts were positively related to performance on the Picture Arrangement subtest of WISC, but unrelated to the verbal ability tests. Accurate performance on the Picture Arrangement subtest requires perceptual analysis of component aspects of the picture. For correct arrangement of the scenes into a coherent theme can only occur if the child attends to subtle cues such as posture of people and direction of travel of objects.

The expectation that syntactically congruent word associations to nouns, verbs, and adjectives would be related to analytic attitude was moderately supported, especially among second grade children. Analytic boys had a strong tendency to respond to nouns with coordinate nouns, to adjectives with antonyms, and to verbs with coordinate verbs. Coordinate nouns, verbs, and antonyms were positively correlated with each other. However, an analytic attitude was unrelated to ease of learning the noun-coordinate noun pairs in the paired-associate learning task.

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[5] For a complete description of other tests given to these subjects see Rosman (1962).

The children who did not give coordinate noun responses produced either verb phrase completions to nouns (e.g., dog-bark), or adjectives describing nouns (e.g., dog-brown). In rare circumstances they produced words unrelated to the stimulus (e.g., dog-pipe, chair-bobby) or rhymes. Most *S*s produced an association that either matched temporal contiguity in language or an association that contained syntactic and semantic communalities with the stimulus. It is not surprising that the latter tendency increased with age, but it is surprising that this tendency was related to an analytic attitude, especially when analytic scores were independent of vocabulary size. The possibility that coordinate nouns or verbs were produced following reflection was not supported by study of the reaction time data. For coordinate responses or antonyms were not associated with longer response latencies on the word-association test.

Analytic Concepts and Impulsive Solution Attempts. It was suggested that a necessary antecedent of analytic concepts was a tendency to delay the reporting of solution hypotheses. One indirect measure of this tendency for delay was the occurrence of initially incorrect answers on HFT. As a first test of this hypothesis, children were classified as above or below the median on number of analytic responses on CST, and this dichotomized variable was related to the occurrence of one or more incorrect answers on HFT (for each grade separately). The resulting chi square was highly significant ($p < .01$), with 25 of the 31 analytic *S*s falling below the median on incorrect hypotheses, and 22 of the 31 low analytic *S*s falling above the median. It might be argued, however, that since analytic responses were positively correlated with HFT performance, low analytic subjects should have higher incorrect answer scores. In order to control for this relation, *S*s high or low on analytic concepts (based on median split) were matched on performance on HFT (i.e., in terms of solution times). Seven matched pairs of subjects were obtained among first grade boys, and six pairs among the second grade boys (total N of 26). Eleven of the 13 analytic *S*s were below the median on production of incorrect hypotheses, whereas 11 of the 13 less analytic *S*s were above the median ($p < .05$). Thus, even when ability to solve HFT was controlled, there was still a strong relation between analytic responses and inhibition of incorrect solution hypotheses.

Analytic Concepts and Indistinct Ink Blot Interpretations. There was no clear relation between analytic responses and indistinct ink blot interpretations when each grade was considered as a whole. However, when verbal facility was controlled by doing separate analyses for boys above or below the median on combined vocabulary and information scores, the expected negative relation between indistinct ink blot interpretations and analytic concepts was significant for boys with average or above average verbal facility (contingency coefficient = .46; $p < .05$), but not significant for boys with below average verbal ability. There was no relation between verbal facility and number of indistinct ink blot interpretations. The absence of a negative relation between analytic concepts and indistinct percepts for boys with low ability is attributable to the fact that many boys with below average verbal skills perseverated with simple form responses (e.g., bat, bird, butterfly) which were not scored as indistinct.

Response Time to Ink Blots. It will be recalled from Table 1 that there was no relation between speed of reaction to the ink blots and analytic concepts. When the relation between these dimensions was assessed separately for boys high and low on verbal facility the expected association between analytic concepts and long response latencies emerged only for boys with above average verbal ability (mean latencies of 7.6 seconds for analytic boys and 4.2 seconds for nonanalytic boys, $p < .05$). Low verbal facility impaired rapid conceptualization of the ambiguous ink blots, and there was a slight negative relationship between verbal facility and response latency.

In sum, the distinctness of the child's ink blot interpretations and the speed of his conceptualizations were influenced by both an analytic attitude and verbal facility. These two dimensions are orthogonal and, as will be seen, are critical determinants of the classificatory behavior of the child.

Summary

The results of this study suggest that an analytic attitude (*a*) appears in a variety of tasks with widely different intellectual requirements (i.e., articulation of ink blots; Picture Arrangement subtest of WISC; HFT performance); (*b*) is independent of vocabulary level; (*c*) is associated with the tendency to inhibit the impulsive reporting of inaccurate responses; and (*d*) is related to the production of word associations that, from a syntactic point of view, are developmentally more mature.

These findings extend and support the results of previous work. The association between an analytic attitude and inhibition of impulsive inaccurate responses is an important clue to understanding the significance of this response, and most of this monograph is devoted to study of the dimension of reflection impulsivity in situations in which *S* must choose among alternative solution hypotheses.

STUDY 2

It appears that analytic responses are produced following reflection over alternative responses. There are several indirect sources of evidence for this statement. First, reaction times to analytic concepts were noticeably longer than response times to other classes of concepts. In one group of second and third grade children (70 boys and 70 girls), the mean reaction time for analytic concepts was 5.8 seconds for boys and 6.9 seconds for girls. The reaction times for relational concepts (the most frequent response category) were 3.9 seconds for boys and 4.6 seconds for girls. This difference in reaction times to analytic versus relational responses was highly significant ($p < .01$). An earlier study (Kagan et al., 1963) reported a mean reaction time of 5.4 seconds for analytic and 4.0 seconds for relational concepts for sixth grade children ($p < .05$). It is interesting to note that the magnitude of the difference between response times for analytic and relational concepts was the same for the older and younger children. Analytic responses are preceded by a delay and it is suggested that during this delay the child is reflecting over alternative responses.

These results, together with those from the previous study (Study 1), suggested the wisdom of initiating an experimental study to test the hypothesis that a set to reflect would increase analytic concepts, a set to respond quickly would interfere with analytic responses. The experiment manipulated the occurrence of analytic responses through the use of instructions requesting the child either to delay before answering or to respond quickly. The three conceptual tests administered were:

1. CST
2. Design Recall Test (DRT). In this task a geometric design was presented for study, removed for 15 seconds, and then presented along with variants on the standard. The *S* had to select the correct design. Analytic performance was characterized by absence of incorrect guesses (i.e., the ability to select the correct answer on the first attempt). Figure 4 contains some sample items.[6]
3. HFT

It was expected that the instructional set to respond quickly would produce fewer analytic concepts and more errors on DRT and HFT than the instruction to reflect. As a control task, the Vocabulary scale from WISC was administered to all children under slow or fast instructions. It was assumed that correct reporting of the definition of a word would not be facilitated by reflection, and total vocabulary scores should be the same for all children.

Procedure

Subjects. The *S*s were 180 second grade children (90 boys and 90 girls). The school had divided the children into three levels of reading ability (based on group test data), and within each of these three groups children were paired on sex, intelligence (California Test of Mental Maturity or CTMM), and education of parents. There was a high relation between reading ability, on the one hand, and both intelligence and parental education level on the other. One member of each pair was placed in a fast instruction group; the second was placed in a slow instruc-

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[6] These stimuli were designed originally by Eleanor Gibson and her colleagues at Cornell University.

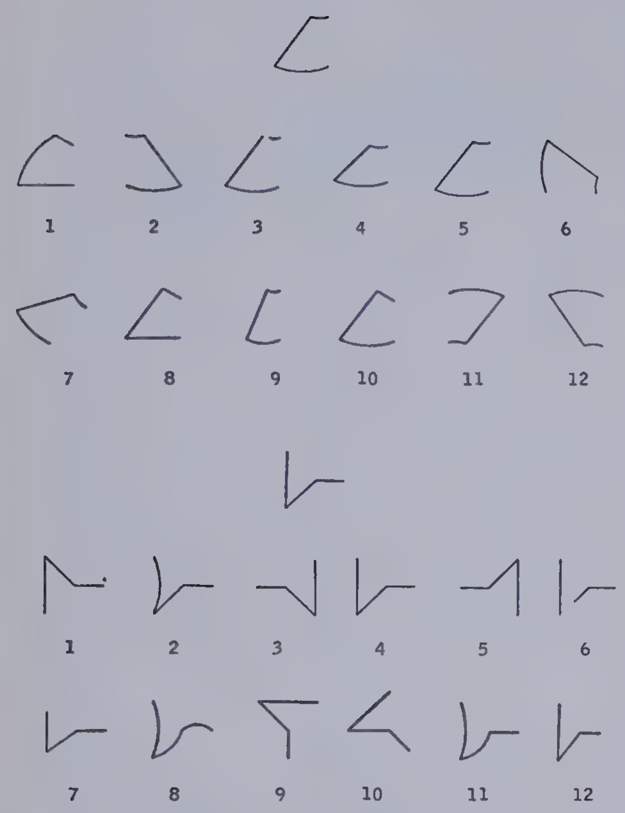

FIG. 4. Sample items from DRT.

tion group. The study involved a $2 \times 2 \times 3$ design with sex, instructional set, and general intelligence (three levels) as discrete variables with 15 subjects in each of 12 cells.

Each child was administered four tests in one 60-minute session. Initially, 120 subjects were administered CST, DRT, HFT, and WISC Vocabulary in one session. This session was too long, and the last 60 subjects were not given HFT. Thus, for the analyses that involve HFT there were only 10 subjects in each of 12 cells.

Administration of Tests.

1. CST—The 30-item CST was administered with two different instructions. The instructions for the *fast* group were:

> I have some cards here with three pictures on them like this one. I want you to pick out two pictures that are alike or go together in some way. Try to get the answer to each card as fast as you can. What two pictures are alike or go together here? Answer as fast as you can.

The instructions to the *slow* group were similar, but *E* added,

> Take your time and think about your answer before telling it to me. What are the two pictures that are alike or go together here? Take your time and think about your answer.

2. DRT—The *S* was first shown a simple geometric design for 5 seconds and told to remember it. The standard was then removed from *S*'s view for 15 seconds after which an array of 8, 9, or 10 similar stimuli was presented. The *S* was instructed to select the one design that was identical to the standard. Each *S* was first given two practice items followed by presentation of 12 test items. Instructions for the fast group included the exhortation,

> Try to pick out the right one as fast as you can.

The instructions for the slow group emphasized reflection,

> When I show you the group of designs take your time before answering so that you are sure that you have picked out the right design.

3. HFT—This was the same test that was administered in Study 1. The instructions for the fast group emphasized speed of response (i.e., "Can you find the fish? Point to the fish as fast as you can."). The instructions for the slow group emphasized reflection (i.e., "Take your time in finding the fish. Make sure you are right before pointing to it.").

4. *Vocabulary*—Each S was administered the Vocabulary scale of WISC. The *S*s in the slow instruction group were told to "think about the answer" before responding. The *S*s in the fast instruction group were told to respond "as quickly as possible."

Results

Table 2 presents the means for the major variables for each of the 12 experimental cells.

The major hypotheses of the investigation were verified, for with slow instructions the children were more likely to (*a*) produce more analytic responses on CST, (*b*) select initially the correct figure on DRT, (*c*) select initially the correct hidden figure (p's $< .001$, $< .01$, $< .001$ by t test, respectively). Analyses of variance for each of these three responses are presented in Table 3.

As predicted, vocabulary scores were not affected by the different instructional sets; the mean scores for the fast and slow groups were identical. The response time to each of the four tasks was clearly influenced by the instruction to delay or to respond quickly $p < .01$ for each task). Thus, the increase in analytic behavior under slow instructions was accompanied by increased delays before responding. Moreover, even within a group given the same instructional set, there was a positive relation between response time and analytic performance. Average correlations for each of the three verbal ability groups (based on z' transformations) were computed among the following five variables: (*a*) response time to CST, (*b*) analytic responses on

TABLE 2

MEAN SCORES FOR CONCEPTUAL VARIABLES

Variable	Instructions (2 levels)—verbal intelligence (3 levels)					
	Fast			Slow		
	High	Medium	Low	High	Medium	Low
CST						
Analytic responses						
Boys	2.3	3.9	1.5	4.6	6.6	3.7
Girls	2.8	3.3	3.5	6.4	4.1	4.0
DRT						
Correct first attempt						
Boys	6.7	5.1	4.4	6.9	6.7	5.4
Girls	6.1	4.5	4.2	7.4	5.7	4.5
DRT						
Errors						
Boys	12.6	18.7	21.1	10.2	12.1	19.5
Girls	13.3	22.9	22.4	11.9	16.9	24.9
Hidden figures						
Correct first attempt						
Boys	9.5	7.6	8.0	10.0	9.6	9.3
Girls	8.8	9.1	8.2	10.6	9.5	8.4
WISC Vocabulary						
Boys	25.9	21.3	21.5	27.5	23.0	15.2
Girls	23.8	17.3	18.3	22.7	21.4	18.1
CST						
Response time						
Boys	3.5	3.0	3.8	6.7	8.5	7.3
Girls	3.0	3.9	3.6	7.5	6.0	6.7
DRT						
Response time						
Boys	4.6	4.3	4.5	8.0	9.0	7.0
Girls	4.5	4.8	4.4	9.6	7.5	7.0
Hidden figures						
Response time						
Boys	10.3	8.6	6.4	13.2	11.3	10.1
Girls	9.7	7.4	6.0	12.2	10.3	10.0
Vocabulary						
Response time						
Boys	3.2	2.4	2.4	4.5	5.0	4.9
Girls	3.1	5.0	2.6	5.1	4.8	5.9

CST, (*c*) response time to first response on DRT, (*d*) number correct on first attempt on DRT, and (*e*) intelligence. The data for HFT were omitted because the sample size was only 10 for each cell.[7] There was a positive relation between number of analytic responses on CST and reaction time for the 30-item test (r's = .40 and .42 for boys and girls in the fast instruction groups, $p < .01$; r's = .25 and .44 for boys and girls in the slow instruction groups, $p < .01$). Similarly, there was a positive relation between number of designs correct on first attempt on DRT and reaction time to first selection ($r = .43$, $p < .01$; and $r = .32$, $p < .05$ for boys and girls in the fast group; r's = .27 and .26 for boys and girls in the slow group). The relevance of delay for an analytic attitude is supported by these positive relations between length of delay be-

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[7] Complete tables of means, standard deviations, or correlation matrices can be obtained by writing to the author.

TABLE 3

SUMMARY TABLES FOR ANALYSES OF VARIANCE

Source	*df*	*SS*	*MS*	*F*
Analytic responses on CST				
Instructions (I)	1	180	180.0	16.4***
Sex (S)	1	2	2.0	
Verbal ability (V)	2	73	36.5	3.3*
I×S	1	6	6.0	
I×V	2	22	11.0	
V×S	2	36	18.0	
I×S×V	2	80	40.0	3.4*
Within (error)	168	1846	11.0	
Number correct DRT first attempt				
I	1	39	39.0	9.30**
S	1	10	10.0	
V	2	137	68.5	16.10***
I×S	1	0	0	
I×V	2	3	1.5	
V×S	2	4	2.0	
I×S×V	2	7	3.5	
Within (error)	168	713	4.2	
Number correct HFT first attempt				
I	1	32	32.0	13.9***
S	1	1	1.0	
V	2	32	16.0	7.0**
I×S	1	1	1.0	
I×V	2	1	1.0	
V×S	2	5	2.5	
I×S×V	2	13	6.5	
Within (error)	108	243	2.3	

* $p < .05$.
** $p < .01$.
*** $p < .001$.

fore responding and either number of analytic responses or number of designs recognized on first attempt.

In a final analysis the matrix of intercorrelations for the 12 major variables was computed. The three intelligence groups were collapsed, and correlation coefficients were based on groups of 45 boys and 45 girls in either the slow or fast instruction group. Coefficients that involved HFT were based on 30 subjects. In this analysis a differentiation was made between major and minor errors on DRT. The most frequent error was the selection of a variant that only differed in size or proportion from the standard (Variants 4 and 9 in top design in Figure 4). The other variants all involved more obvious distortions of the standard, e.g., changes in the curvature of designs, changes in the orientation of the design, breaks in the continuity of a line (Variants 1, 2, 3, 6, 7, 8, 10, 11, and 12 in Figure 4). In Tables 4 and 5 major errors refer to the more obvious alterations which occurred less frequently; minor errors refer to the more common error in which the child selected a stimulus differing only in size or proportion from the original. The coefficients appear in Tables 4 and 5.

Analytic concepts on CST showed a negative relation to major errors on DRT (r's $= -.16, -.25$ for *S*s in fast group; r's $= -.11, -.41$ for *S*s in slow group; average $r = -.24$, $p < .01$). Analytic responses were, as expected, not highly related to standard IQ score (r ranged from $-.16$ to $.16$). When the analysis was restricted to children given either fast or slow instructions, there was still a strong, positive relation between number of analytic concepts on CST and response time across all 30 items (r's $= .26, .46, .32, .39$; p's $< .10, < .01, < .05, < .01$). Further, there was intraindividual consistency in the tendency to have long response times on both CST and DRT (r's $= .43, .53, .49, .36$; $p < .05$ for all coefficients). For children under slow instructions there was even a positive correlation between response times on HFT and CST ($r = .33$, $p < .10$; $r = .59$, $p < .001$). Finally, response times to HFT and DRT were positively correlated (r's $= .31, .10, .39$, and $.26$; the boys' coefficients of .31 and .39 were significant at $p < .10$ and $< .05$, respectively). It is to be noted that response times to CST, DRT, and HFT were independent of vocabulary scores (11 or 12 coefficients fell between $-.16$ and $.16$). This finding is replicated in other studies to be summarized.

Unlike analytic concepts on CST, accurate performance on DRT had a moderate relation to IQ score on CTMM. This could be due to several factors. First, DRT involved memory. The ability of a second grade child to retain a clear image of a meaningless geometric design for 15 seconds may be facilitated by the availability of language labels that enable the child to classify the design. The stimuli used in the test were relatively meaningless forms and the child with a rich vocabulary may have been more likely to

TABLE 4

INTERCORRELATIONS AMONG COGNITIVE VARIABLES FOR CHILDREN UNDER FAST INSTRUCTIONS

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. CST, Analytic responses	—	.26*	−.16	−.21	.25*	.10	.04	−.13	.14	−.10	.22	−.16
2. CST, Response time	.46***	—	−.08	−.21	.13	.43***	.18	−.08	.15	−.07	−.15	−.22
3. DRT, Major errors	−.25*	−.16	—	.45***	−.72****	−.27*	−.48***	.46***	−.23	−.13	−.46***	−.54****
4. DRT, Minor errors	−.18	.03	.46***	—	−.70****	−.43***	−.34*	.38**	−.07	−.08	−.17	−.21
5. DRT, Correct first attempt	.22	.04	−.57****	−.62****	—	.38***	.55***	−.52***	.30*	.02	.40***	.52****
6. DRT, Response time	.36**	.53****	−.36**	−.22	.33**	—	.26	−.22	.31*	−.10	−.11	.13
7. HFT, Correct first attempt	−.23	−.01	−.05	−.06	.35*	.04	—	−.83****	.26	.28	.26	.31*
8. HFT, Total errors	.11	−.17	.27	.24	−.39**	−.20	−.87****	—	−.44**	−.08	−.31*	−.29
9. HFT, Response time	−.01	.03	.00	−.12	.26	.10	.18	−.17	—	−.62****	.13	.11
10. Speed of solution	−.41**	−.38**	−.09	−.06	.22	−.39**	.32*	−.23	−.36**	—	−.04	.01
11. WISC, Vocabulary	.10	−.09	−.37**	−.15	.18	−.13	−.09	−.05	.16	.24	—	.31**
12. IQ (CTMM)	.05	−.25	−.38***	−.38***	.32**	−.15	−.14	.08	.37**	−.05	.54****	—

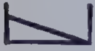
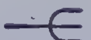
Note.—Males to the right and above the diagonal; females to the left and below.
* $p < .10$, two tailed.
** $p < .05$, two tailed.
*** $p < .01$, two tailed.
**** $p < .001$, two tailed.

TABLE 5

INTERCORRELATIONS AMONG COGNITIVE VARIABLES FOR CHILDREN UNDER SLOW INSTRUCTIONS

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. CST, Analytic responses	—	.32**	−.11	−.07	−.10	.16	−.08	−.12	.25	−.32*	.15	.16
2. CST, Response time	.39***	—	−.09	−.03	−.02	.49****	−.13	.21	.33*	−.46***	−.16	.05
3. DRT, Major errors	−.41***	−.16	—	.59****	−.76****	−.22	−.50***	.52***	−.13	−.11	−.33**	−.45***
4. DRT, Minor errors	−.37**	−.19	.72****	—	−.73****	−.38***	−.29	.58****	−.40**	.06	−.22	−.31**
5. DRT, Correct first attempt	.32**	.20	−.79****	−.84****	—	.33**	.42**	−.55***	.28	.00	.15	.35**
6. DRT, Response time	.28	.36**	−.27*	−.36**	.37**	—	.01	−.26	.39**	−.50***	.13	.24
7. HFT, Correct first attempt	.37**	.48***	−.46***	−.43**	.39**	.40**	—	−.67****	−.11	.40**	.37**	.04
8. HFT, Total errors	−.35*	−.54***	.37**	.36**	−.39**	−.33*	−.89****	—	.00	−.19	−.30*	−.10
9. HFT, Response time	.41**	.59****	−.16	−.02	.11	.26	.05	−.13	—	−.76****	−.11	.07
10. Speed of solution	−.14	−.47***	−.07	−.12	.06	−.29	.12	.00	−.75****	—	.25	−.02
11. WISC, Vocabulary	.34**	.12	−.37**	−.50****	.43***	.36**	.52***	−.43**	.25	.01	—	.50****
12. IQ (CTMM)	.07	.13	−.32**	−.37**	.45***	.35**	.40**	−.35*	.16	−.06	.44***	—

Note.—Males to the right and above the diagonal; females to the left and below.
* $p < .10$, two tailed.
** $p < .05$, two tailed.
*** $p < .01$, two tailed.
**** $p < .001$, two tailed.

apply a label to the design that facilitated its subsequent retention. For example, the design  was called by some children a "tilted glass of milk"; and  was sometimes called a "pitchfork." The child who was quick to apply such labels might be expected to perform better on this test than one who did not use this verbal device. Finally, DRT resembled a school task more than CST. It was relatively difficult, and there was clearly a right answer. The child of average intelligence may not have invested intense interest in the task because of minimal desire to perform competently or minimal confidence in his ability to perform adequately.

The HFT was too easy for this group, for over 90% of the children solved the designs within 20 seconds. Thus, the critical measure on this task was not solution time, but the *S*'s approach to the task (i.e., reaction time to first guess and number of errors before achieving solution). It will be recalled that children who achieved many initially correct solutions on HFT also achieved many initially correct solutions on DRT, indicating that reflection over alternative responses was consistent across the two tests.

Discussion

These data argue for the significance of a dimension of reflection versus impulsivity in problem situations where many solution hypotheses are available simultaneously, and the child has to evaluate the differential adequacy of each possibility. Some children act first and discover later if they were correct; others reflect before responding, eliminating potentially incorrect answers mentally.

The importance of this subtle cognitive process may not be fully appreciated. An impulsive approach to problem solving is likely to be associated with the execution of solution hypotheses that are incorrect. The impulsive child is apt to act upon his initial hunch with minimal reflection, carry through a false hypothesis mentally, and offer an answer without critical examination of its potential accuracy. The anxiety resulting from repeated failure, as a consequent of impulsive reporting, could lead to generalized expectations of failure and withdrawal of involvement from intellectual tasks.

STUDY 3

The previous study suggested that the tendency to inhibit impulsive, inaccurate answers to problems with alternative solution possibilities was consistent across tasks and amenable to experimental manipulation. This investigation is a partial replication and extension of the previous one. The primary purpose was to assess the relation between analytic concepts on CST and impulsive errors on DRT under a "normal" testing situation (i.e., where the child was not urged to respond either quickly or slowly). A second purpose was to test the hypothesis that children with high analytic scores would reflect over their cognitive products and examine them for completeness and accuracy. Children were asked to draw an object with which they were all equally familiar—a human face—and their products were examined for differences in completeness.[8] The analytic *S*'s product was expected to contain more relevant elements than that of the less analytic child. A final purpose was to replicate an earlier unpublished finding of a low positive relation between the tendency to produce analytic concepts and the ability to prolong the simple motor task of drawing a straight line.

Procedure

Subjects. The *S*s were 72 boys (35 in Grade 2 and 37 in Grade 3) and 63 girls (34 in Grade 2 and 29 in Grade 3) whose ages ranged from 6-10 to 9-6 with a median age of 7-10. Of the total group of 135, 112 were Caucasian, 20 were Negro, and 4 were of Oriental background. Most of the boys (77%) were seen in Study 1.

The educational level of the parents ranged from part high school to professional training; the modal educational level was high school graduate. All *S*s were seen individually for two 60-minute sessions by a young adult of opposite sex to the child. The two sessions were separated by a period of 9 weeks.

Administration of Tests: Session I.

1. CST—The 30-item CST was administered to each child with standard instructions. The two vari-

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[8] This idea was suggested by G. A. Miller.

ables coded were (*a*) analytic responses and (*b*) mean response time to all 30 items.[9]

2. Delayed Recall Designs Test (DRT I)—This task was administered as in Study 2, but *S* was told neither to respond quickly nor slowly. He was left to respond according to his own natural tempo. As in Study 2 the most frequent error was to the variant in which the stimulus was identical in shape and orientation to the original, but the proportion was altered in a minor way (called a minor error). All of the other variations on the standard included changes either in a part of the stimulus or in its orientation (major errors). Two different error scores were computed as well as mean response time across all 12 items, and number of items for which *S*'s first selection was correct.

3. Motor inhibition task: Draw-a-line (DAL)—The *S* was asked to draw a straight line as slowly as possible. The *E* first drew part of a line very slowly and then asked *S* to

> Draw a line like this but go as slowly as you can. You can't stop and you can't take your pencil off the paper. I'll tell you when to start. O.K. Go.

After *S* had drawn the line *E* said,

> Now I want you to do this once more. But go even slower. Do the same thing but try to make the line even slower.

The variables analyzed were the time taken to complete the line for each trial (DAL I, DAL II).

4. Verbal fluency (VF I)—The child was asked to think of as many things as he could that were round, and each *S* was given 2 minutes to respond. The only variable of interest was the number of appropriate items named. This task was included as a control task; it was expected that the fluency score would be unrelated to measures of analytic attitude.

Administration of Tests: Session II (9 weeks later).

1. Picture Discrimination Test (PDT)—The *S* was shown two similar pictures and asked to detect the difference between them. The items were taken from Meier's Art Preference Test. After four practice items a set of 15 test items was administered, with a time limit of 2 minutes allowed for each item If *S*'s initial answer was incorrect *E* said,

> That is not the most important difference. Can you find another way in which the pictures differ?

The *E* allowed the child to guess as many times as he wished within the 2-minute period. Figure 5 presents two sample items from the test.

The major variables coded were (*a*) number of incorrect solution hypotheses, (*b*) number of items for which *S*'s first solution hypothesis was correct, and (*c*) average time to solution across all 15 items.

After PDT, *S* was administered a special task designed to assess his perception of school. These data will not be reported here.

2. Design Recall Test (DRT II)—The DRT was administered again with the same instructions used in the first session, but the items were presented in a different order.

3. Verbal fluency (VF II)—Each *S* was given a second verbal fluency task in which he was asked to report all things that he could think of that were square in a 2-minute period.

4. Draw-a-face (DAF)—The *S* was requested to draw a human face as if he were looking at it. The order of appearance of each of the face parts was recorded by *E*. The major variables scored were the number of parts included (i.e., eyes, nose, mouth, ears, hair, wrinkles, etc.) and the order of appearance of each part.

In addition, language and nonlanguage IQ scores based on CTMM were available for 92% of the children. This test had been group administered to *S*'s prior to the two test sessions.

Results

Sex Differences. There were significant sex differences in mean scores for some of the variables (see Footnote 7). Boys, in comparison to girls, produced more analytic responses ($p < .001$), higher fluency scores ($p < .01$), and more errors on PDT ($p < .05$). Grade 3 boys produced less major errors on both DRT I and II than Grade 3 girls ($p < .05$) and took a significantly longer time to draw the straight line than third grade girls ($p < .01$ for Trial 1 and $p < .05$ for Trial 2). Girls, on the other hand, had higher scores than boys on average response latency to CST ($p < .01$), average latency to first response on DRT I and II ($p < .01$ and $p < .001$, respectively), and number of face parts ($p < .05$). In sum, boys produced more analytic concepts and fewer recognition errors on DRT, despite the fact that girls had longer response times to CST and DRT. The longer response times among girls were no guarantee that they would make fewer errors on these visual analysis tasks.

Age Differences. Third grade boys made fewer major errors on DRT than second grade boys for both sessions ($p < .05$); but third grade girls made slightly more errors than second grade girls. This latter difference just missed statistical significance. Fluency scores and number of face parts drawn increased with age for both sexes ($p < .01$ and $p < .05$).

Intercorrelations among the Variables. In-

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[9] The scores for the 55 boys for whom this was the second administration of CST were based on their performance on this second test.

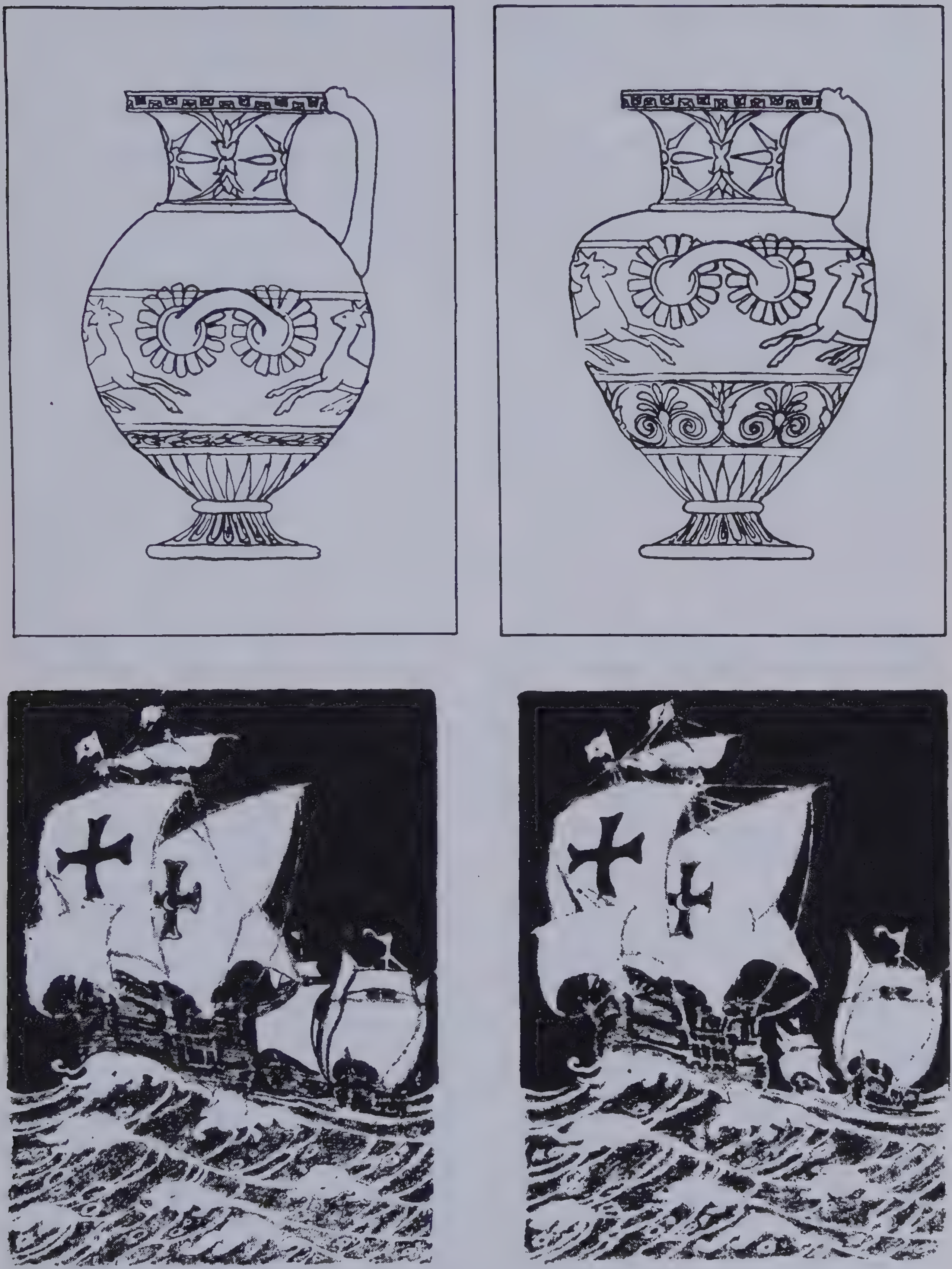

FIG. 5. Sample items from PDT.

tercorrelations among these variables (scores were transformed to McCall *T* scores) were computed for the four sex-grade groups separately (see Footnote 7). There are several sets of provocative relations contained in these coefficients.

Consistency of Response Time Scores. The child's tendency to display long or short response times on CST, DRT I, and DRT II was highly consistent. The intercorrelations among these three response times were all positive (r ranged from .21 to .77 with an average r of .49), and 10 of the 12 coefficients were statistically significant at .05 or better. The coefficients relating response times on DRT I and II were .77 and .29 for boys ($p < .001$ and $p < .10$), and .50 and .66 for girls ($p < .01$ and $p < .001$). These correlations were similar in magnitude to those reported in Study 2, and support the conclusion that the tendency to delay before responding in a situation with many alternatives shows intraindividual consistency across situations and stability over a 9-week period.

Consistency of Error Scores. The reliability of major and minor error scores on the two administrations of DRT was unusually high. All eight coefficients were significant and ranged from .29 to .84 with an average r of .58. The reliability of the major error score was slightly greater than the minor error score. The unusually high coefficient of .84 for major errors occurred among Grade 3 girls. Subsequent investigations on an independent sample of 70 second grade children yielded a reliability coefficient of .55 for DRT errors with a test-retest interval of 7 months. The intratest reliability (odd-even) for total errors was .77 for the present group of second and third graders.

A tendency to offer incorrect solution hypotheses on PDT was positively related to major errors on both administrations of DRT for second grade *S*s, but not for third graders. For the Grade 2 *S*s the four correlations ranged from .52 to .73 (all significant at $p < .01$). It will be recalled from Study 2 that errors on DRT were positively related to errors on HFT (r ranged from .27 to .58).

Relation between Response Time and Errors. There was a consistent negative relation between response times on CST or DRT and error scores on DRT I, DRT II, and PDT. As might be expected the relationship was highest when response times and error data came from the same test. For example, the relationship between major errors and response time on DRT I was −.45, −.29, −.42, and −.55 for the four groups. For DRT II the coefficients ranged from −.09 to −.48 with an average r of −.28. There was typically a strong negative relationship between response time on one task and errors on a second task. To illustrate, response time to CST was negatively associated with major errors on DRT I for three of the four groups (r's = −.42, −.26 for boys; r's = .11, −.28 for girls). Similarly, long response times to DRT I were negatively related to major errors on DRT II for three of the four groups (r's = −.44, .00 for boys; r's = −.32, −.51 for girls). Indeed, for second grade boys the relation between response time and major errors on DRT I ($r = -.45$) was no better than the relation between response time on DRT I and major errors on DRT II 9 weeks later ($r = -.44$). These data are consonant with those of Study 2, for response times to DRT were negatively related to errors on both DRT and HFT.

In sum, these children showed a *stable tendency toward delay versus impulsivity in reporting solution hypotheses,* and this tendency was *consistently related to low versus high error scores on DRT.*

Relationships with Analytic Responses. The index of analytic attitude was the number of analytic responses on CST. The pattern of correlations between analytic concepts and the other variables was in a direction that might be expected. Analytic responses were associated with slightly longer response times to CST (r's = .21 and .27 for boys; r's = .07 and .32 for girls), and with longer response times to the DRT I for second grade girls ($r = .46$; $p < .01$), and for third grade boys ($r = .32$; $p < .05$). The correlations for the other two groups were .07 and .10. Analytic responses were also associated with low major error scores on DRT I and II for all groups ($r = -.36$, $p < .05$ and $r = -.48$, $p < .01$ for boys; r's = −.27 and −.50; $p < .01$ for girls). These correlations were somewhat higher than the corresponding coefficients in Study 2 where the subjects were given a set to delay or respond quickly. Finally, analytic responses were associated with low error scores on PDT for three of the four groups ($r = -.33, p < .05$ and $r = .14$ for boys; $r = -.42$, $p < .05$ and $r = -.48$, $p < .01$ for girls). There was a suggestive positive relation between analytic concepts and number of face parts drawn (average $r = .17$; $p < .05$). Analytic concepts were, as predicted, independent of verbal fluency scores, but moderately related to language IQ (r's $= .23$ and .35 for boys; r's $= .46$ and .21 for girls). The magnitudes of these relationships between group administered test scores and analytic concepts were the highest obtained in any of the studies during the last 4 years. Since group administered IQ tests have a multiple-choice format it is not unlikely that an analytic attitude could facilitate performance on this kind of instrument. However, when language IQ was partialed out through a regression analysis, the magnitude of the relation between analytic concepts and the other variables did not change to an appreciable degree. For example, analytic concepts remained negatively related to major errors on DRT I and II ($r = -.30$, $p < .10$ and $r = -.54$, $p < .01$ for boys; $r = -.53$, $p < .001$ and $r = -.23$ for girls).

Significance of Face Parts. All children drew the eyes, nose, and mouth, and differences in scores reflect the addition of attributes such as ears, hair, eyebrows, eyelashes, wrinkles, and teeth. It is suggested that one of the primary factors responsible for high scores on this task is the tendency to reflect on what a face is like while executing the drawing or after it is completed. The child who reflects on the adequacy of his production is apt to include more attributes than one who impulsively draws what first occurs to him and fails to reflect on the completeness of his product. These ideas are supported, to some degree, by the correlation between the number of face parts drawn and other variables. High scoring boys had longer reaction times to CST (r's $= .32$ and .35) and DRT (r's $= .29$ and .29) and made fewer minor errors on the DRT (r's $= -.47$ and $-.42$). There was no relationship between number of face parts drawn and IQ. For third grade girls, number of face parts was related to long response times on CST ($r = .49$) and, as with boys, was independent of IQ score.[10]

DAL. The ability to prolong the drawing of a straight line was stable across the two trials (r's $= .80$, .87, .89, .81), orthogonal to language IQ, and most clearly related to low error scores on DRT. For example, time to draw the line on Trial 1 was negatively related to minor errors on DRT I (r's $= -.44$ and $-.39$, for boys; r's $= .03$ and $-.20$ for girls) and to major errors on DRT I (r's $= -.54$, .05, $-.18$, $-.27$).

Fluency. The verbal fluency scores were also relatively stable across the two sessions (r's $= .63$, .69, .29, .52), but were generally unrelated to the other variables. The direction of the relationships favored a slim association between fluency and fast response times. To illustrate, the relationship between fluency for round objects and response time on DRT I was $-.11$ and $-.33$ for boys; $-.17$ and .12 for girls.

Discussion

These results, together with those from Study 2, provide persuasive evidence for the postulation of a construct of reflection versus impulsivity in offering solution hypotheses when several responses are available simultaneously. The purest measure of this construct is response time to first selection in tests like DRT. The relation between analytic concepts and response time or errors on DRT was only moderate. Thus, the determinants of an analytic concept must involve variables other than active reflection upon alternatives. One of these additional variables will be discussed in a later study.

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[10] There was a significant age difference in the order in which the hair was drawn. Third grade children were not only more likely to include the hair than second graders ($p < .05$), but they were apt to draw it early (i.e., the first or second item produced). For the boys 33% of the third graders and 11% of the second graders drew the hair as the first or second component of the face. For girls 62% of the third graders and 29% of the second graders drew the hair early. The resultant chi square for the pooled sexes was 10.20 ($p < .01$). One interpretation of the increased salience of the hair with age assumes that type of haircut is a critical external criterion for sex-role differentiation. The age difference in the inclusion of the hair early in the drawing may reflect a heightened concern with sex-role differentiation in third grade children. It is possible that the order in which elements of a schema are expressed (in verbal or graphic form) might provide an indirect index of the individual's preoccupation with that element.

Although this line of inquiry began with CST, the results of several studies have led to a concern with a dimension (i.e., reflection-impulsivity) for which CST is not the best measuring device. An analytic response is complex and multiply determined, and it seems wise to concentrate on each of its more basic determinants. It is not uncommon that a new instrument acts as a wedge to uncover significant phenomena which in turn dictate the discarding of the original instrument. The phrase analytic attitude in this monograph shall refer specifically to analytic concepts on CST; whereas, the reflection-impulsivity variable refers to response time, when it is understood that long response times are associated with low error scores.

This study also yielded other ideas that warrant systematic study. The low, but suggestive, negative relation between fluency and reflection is intuitively reasonable. The child who pauses to evaluate the validity of each hypothesis should produce less volume in a brainstorming task like verbal fluency. The meaning of a fluency score, as suggested by the writing of Guilford (1959) and Getzels and Jackson (1962), is consonant with these data.

The fact that reflective *S*s drew more face parts has methodological consequences for investigators who use children's drawings as an index of the child's perception or mental constructions. Piaget and his colleagues (Inhelder and Piaget, 1958) occasionally use a child's drawings as a measure of his conception of an event. The Geneva investigators interpret developmental differences in the child's graphic productions as isomorphic with the child's understanding of an event. The present data indicate both age and individual differences in the accuracy and completeness of the reproduction of a face, an object for which the child has complete familiarity. When the child omits ears or hair in his drawing it is more reasonable to assume that he failed to reproduce these components as a result of inadequate reflection, rather than conclude that he does not know that people have hair or ears.

The *S*s in this study recently viewed six different line drawings, presented tachistoscopically, a minimum of 18 times at increasing exposures. The child reported what he saw after each exposure. After the last exposure *S* was told to look at the picture once more (at a 3-second exposure) and to draw it. It was not uncommon for a child to omit completely from his drawing an aspect of a scene he had described accurately a few seconds earlier. Moreover, there was a positive relation between completeness of the six drawings and both analytic concepts (average $r = .28$, $p < .01$) and number of face parts drawn (average $r = .29$, $p < .01$), and a negative relationship with errors on DRT II (average $r = -.30$, $p < .01$).

These additional data strengthen the earlier statement that differences in cognitive products should not always be attributed to differential knowledge, but may be a consequence of differences in the maturity of the response systems the child uses to communicate to *E*, be it a verbal explanation, a drawing, or a finger pointing to a picture. Psychologists should be more cautious about glibly attributing developmental differences in cognitive performance to differences in cognitive structures when it is likely that both classification and response processes are also changing systematically with age.

STUDY 4

The data summarized in the first three studies suggest the role of reflection impulsivity in facilitating analytic concepts on CST. A second dimension implied by the phrase "analytic attitude" is analysis (or fractionation) of visual stimuli. For an analytic concept on CST is a grouping based on similarity in *component* parts of the total stimulus. One way to test the notion that analytic concepts are produced by children who are predisposed to analyze stimuli is to require the child to learn a label to a new stimulus, and to assess, subsequently, the child's ability to apply this label correctly to component parts of the original stimulus.

Results from an early study (Kagan et al., 1963) revealed that fourth graders who produced many analytic concepts were more likely than less analytic children to attach a nonsense syllable to discrete parts of a geometric design. Briefly, 25 boys and 25 girls were administered a simple paired-associate learning task in which the child was required to learn four different nonsense syllables to each of four geometric designs. Figure 6 (bottom section) illustrates these designs.

After reaching a criterion of eight successive correct responses *S* was shown the figure and ground components separately (top half of Figure 6) and asked to apply the correct syllable. The girls made significantly more errors than boys when the figural component was presented alone ($Ms = 3.0$ versus 1.7, $p < .01$). Further, the boys and girls who produced many analytic concepts on CST were more likely to label the figure correctly when it was presented alone than less analytic children. The correlation between analytic concepts and frequency of correct labeling of the figure elements was .32 ($p < .05$).

Replication

In order to assess the generality of this result, a replication was initiated. A second purpose was to replicate the relation of analytic attitude to two variables already studied—the ability to detect differences between highly similar stimuli (using PDT) and the ability to prolong the drawing of a straight line.

Procedure

Subjects. The *S*s were 57 fourth grade boys; *E* was a female college student.

Administration of Tests.

1 CST—Each *S* was given CST with standard instructions.

2. Visual analysis—Each *S* was administered the four pairs of geometric designs illustrated in Figure 6, and asked to learn a nonsense syllable to each design until he reached a criterion of eight consecutive correct responses. After reaching criterion each *S* was shown the figure and ground components separately (eight stimuli in the transfer set) and applied the syllable he believed was correct.

3. PDT—This test contained 19 pairs of pictures which differed in a subtle aspect (see Figure 5 for illustrations). The instructions to the child were "to find the most important difference between them." The *S* was allowed 2 minutes to find the difference between them and was not told if his answer was correct or incorrect.

4. Second transfer trial: Visual analysis—Each *S* was again presented with the eight stimuli (in a different order) that contained the separate figure and ground elements.

5. DAL—Each *S* was asked to draw a straight line as slowly as possible. After the first trial, *E* told *S* to, "do it again, even slower, more slowly this time." The *S* then repeated the task.

6. Intelligence—Scores on the Pintner-Cunningham IQ test (group administered) were available for 43 of the 57 boys.

Results

Table 6 contains the correlations between analytic concepts on CST and each of the other major variables.

Analytic responses were associated with correct recognition of the figural element of the original design. There was no relationship between analytic concepts and either correct labeling of the background or ease of learning the association between nonsense syllable and the whole design.

Analytic boys were also better able to detect the differences between the two similar pictures on PDT. This study was completed before the results of Study 3 were analyzed, and at the time the importance of obtaining number of incorrect hypotheses on PDT was not recognized. Finally, there was only a slight relation, but in the predicted direction, between analytic concepts and the ability to prolong the drawing of the straight line. As

TABLE 6

RELATION BETWEEN ANALYTIC CONCEPTS AND OTHER VARIABLES

Variable	Correlation
Visual analysis,	
Trial of attainment	.14
Visual analysis,	
Figural component correct	.26**
Visual analysis,	
Background component correct	—.09
PDT, Failures	—.41***
DAL speed,	
Trial I	—.13
Trial II	—.09
Trials I and II (average)	—.25*
Intelligence ($N = 43$)	.24

Note.—$N = 57$ fourth grade boys.
* $p < .10$, two tailed.
** $p < .05$, two tailed.
*** $p < .01$, two tailed.

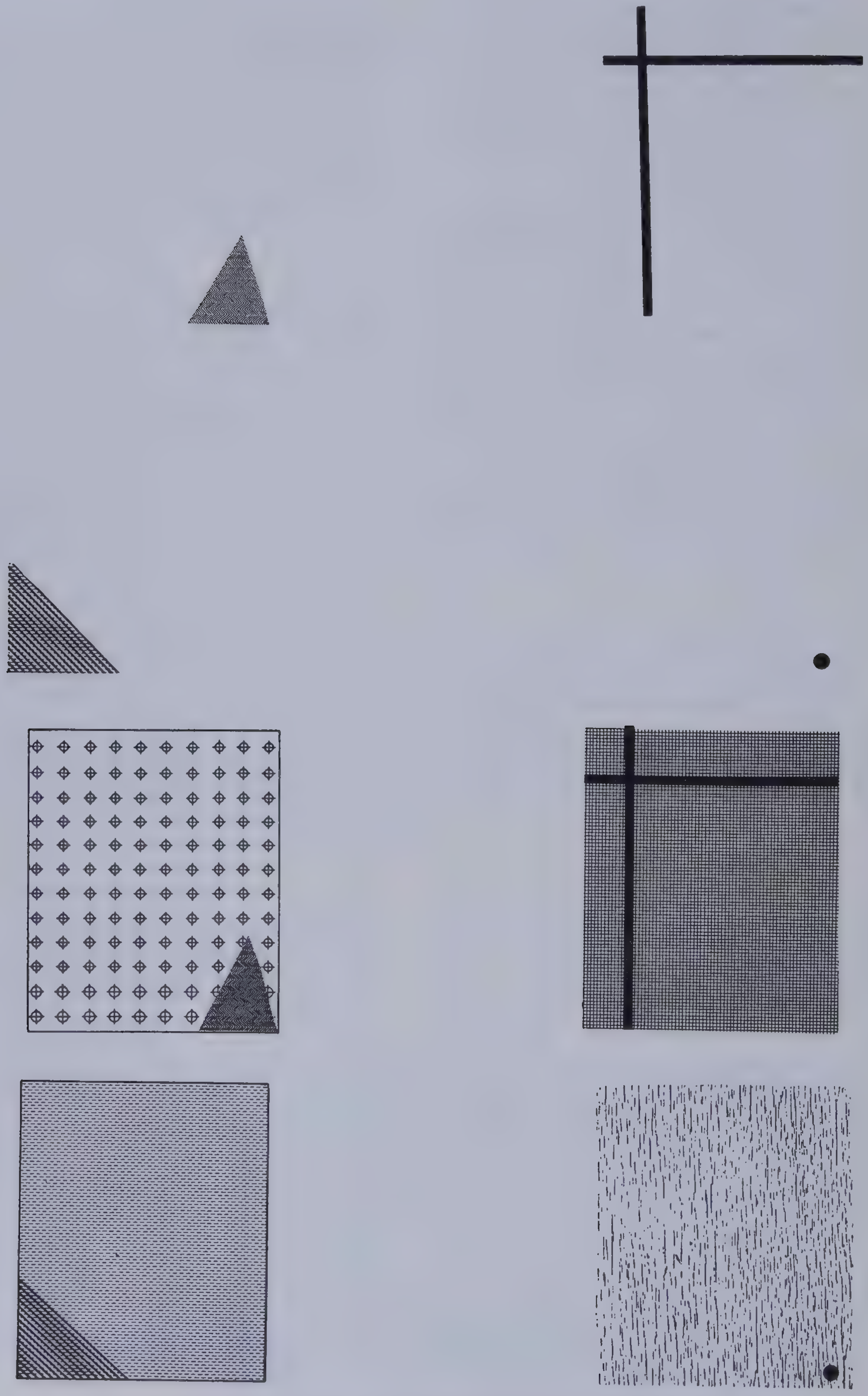

FIG. 6. Stimuli used in figure-ground learning task.

in most of the previous studies, there was no strong relation between analytic concepts and IQ score.

Discussion

These data, together with those from Studies 1, 2, and 3, suggest that analytic concepts are related to two distinct variables: the tendency to analyze a stimulus into its elemental components and the tendency to inhibit impulsive answers. The joint influence of these two variables on analytic concepts will be examined later in the monograph.

STUDY 5

The data summarized revealed a moderate association among analytic concepts on CST, reflection over alternative-solution hypotheses, and visual analysis. But the relation between visual analysis and reflection had never been assessed. Since DRT and CST had been administered to groups of second and third graders 1 year earlier (see Study 3), it was decided to retest this group in an attempt to ascertain the relation among all three variables.

The two major components of the new battery were new measures of visual analysis and reflection. The stimuli in the new visual analysis test contained three component parts (in contrast to the stimuli of Study 4 that contained only two components). The background component was a repetitive pattern; whereas, the figural component referred to the form into which the individual-element components fell. That is, the elements were discrete geometric forms that traced out a definite figural form. The figural component, when presented alone, contained no clue as to the original elements that composed it, and the element, when presented alone, contained no clue as to the figural form it assumed in the original stimulus. Figure 7 illustrates one of the items; the stimulus in the upper-left corner was the original design.

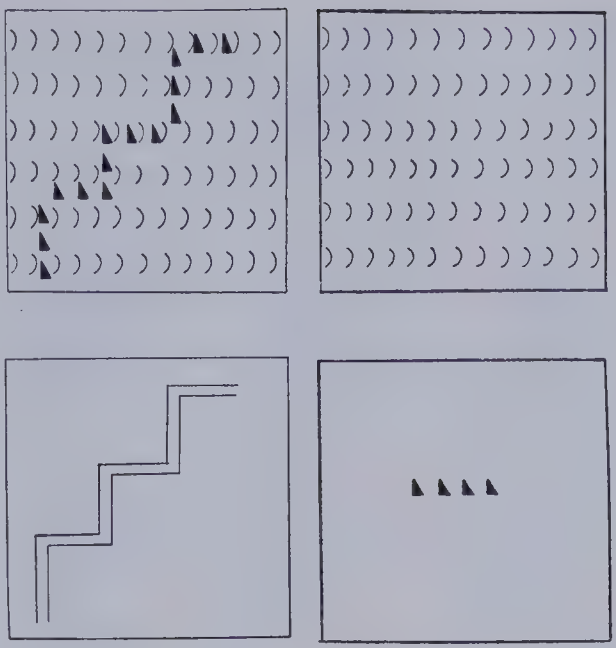

FIG. 7. Sample item from visual-analysis task.

The new task of reflection was similar to DRT, but differed from it in two ways. First, the stimuli were familiar objects (telephone, boat, cowboy) rather than geometric designs. It will be recalled that there was a low-positive relation between accurate performance on DRT and IQ score. It was suggested earlier that this relation might be lower if the items illustrated familiar objects rather than geometric designs. Second, DRT included an immediate memory component, for *S* had to retain the image of the standard for 15 seconds before being allowed to select the variant that he thought was identical to the standard. The new test of reflection did not require memory. The standard and variants were presented simultaneously, and *S* had to select the variant that was identical to the standard. Since memory was not involved the job of detection was made more difficult and the variants were more similar to each other than was the case in DRT. This task was called Matching Familiar Figures (MFF). Figure 8 illustrates two test items.

Procedure

Subjects. The *S*s were 60 boys and 53 girls in Grades 3 and 4 all of whom had been seen a year earlier in Study 3. Each *S* was seen individually at the institute by a female *E*.

Administration of Tests.

1. Visual analysis: Task 1—The *S* was required to learn four different nonsense syllables to each of four designs. The *S* was then presented with cards containing the four nonsense syllables and the stimuli that illustrated the separate components. The transfer task contained two examples each of the ground, figural, and element components (24 stimuli in all)

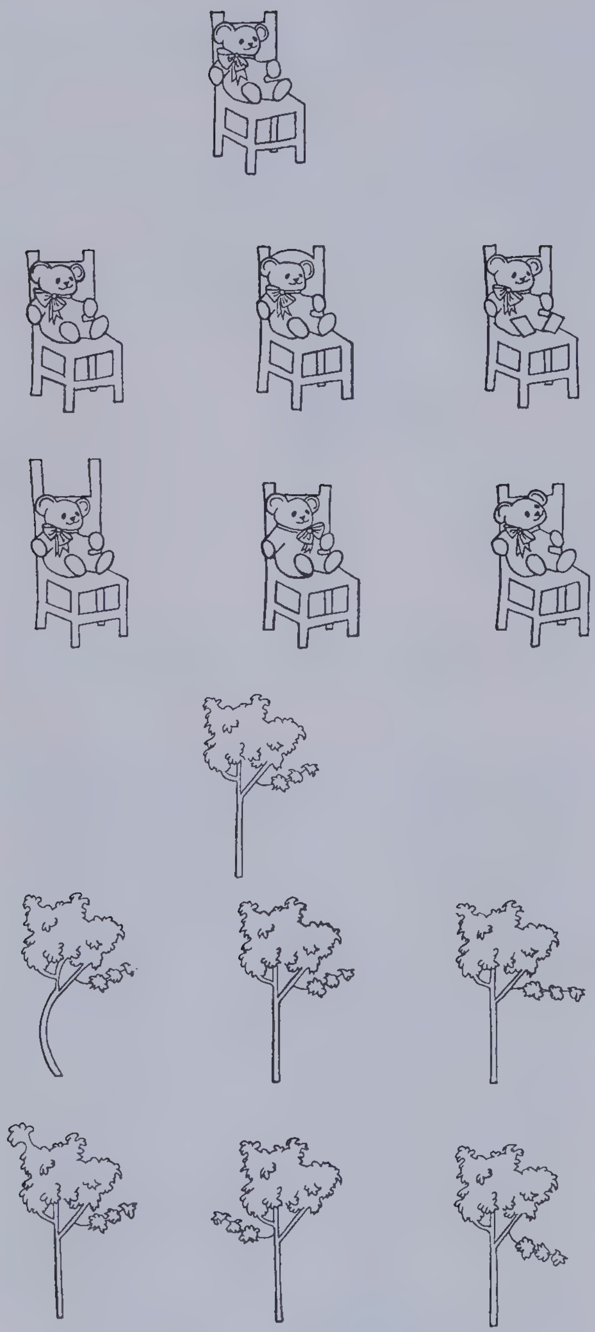

FIG. 8. Sample items from MFF.

arranged in a random order. The *S* was not told if his answers to the separate components were correct.

2. Visual analysis: Task 2—After an intermediate task (MFF) *S* was asked to learn a new set of nonsense syllables to four new stimuli. The procedure was the same as for Task 1. After reaching criterion *S* was shown the separate components (24 in all) and asked to apply the correct nonsense syllable.

The variables scored for each of the tasks were trials to attain criterion; number of ground, figural, or element components correctly labeled on the transfer task; and mean response time for the delay between presentation of the individual ground, figural, or element components in the transfer task and *S*'s answer. It was hoped that response time in the transfer situation would be related to decision times in other situations.

3. MFF—This test was administered between the two visual analysis tasks. The *S* was asked to select the one stimulus from the array of six variants that was identical to the standard. The *S* was given two practice items followed by 12 test items. If *S*'s initial selection was incorrect, he was told he was wrong and was asked to try again. The variables scored were response time to first selection, total errors, and number of test items correct on the first choice.

4. Vocabulary—Each *S* was given the vocabulary scale of WISC. Several months after this session each *S* was also administered the information and similarities scales of WISC and average scaled scores for the three tests were computed.

Results

Visual-Analysis Scores. The figural aspect of the stimulus was clearly the preferred focus of attention (see Footnote 7). All *S*s were most accurate in labeling this component during the transfer trial for Task I. Figural components were also the best recognized for Task 2, but the differences were not as marked. For Task 1 the difference between correct recognition of figure versus element was significant ($p < .01$) as was the comparison between figure and background ($p < .01$, by t tests). For Task 2 these differences were in the same direction but reduced in magnitude.

As might be expected, many *S*s realized after Task 1 that they were not attending to the ground and element components and correct recognition of these categories increased from Task 1 to Task 2, while correct figure recognition decreased slightly. Most of the children shifted their preferred focus of attention from figure to ground and element components after Task 1.

Sex Differences. The boys were more likely than the girls to analyze the stimulus during learning; the differences were most marked for figural and element components for Task 1. The sum of correct background, figure, and element recognitions for each task separately or for both tasks was higher for boys than for girls ($p < .01$ for each comparison). This result matches the sex difference found in the earlier study with simpler stimuli and supports the general belief held by psychologists that school-age boys are more analytic than girls.

There was no sex difference in errors or average response time on MFF.

Age Differences. As expected, the fourth graders had slightly better visual analysis scores on both tasks ($p < .01$) and made less errors on MFF ($p < .01$) than the third-grade children.

Intercorrelations among the Variables. A matrix of correlations among the variables derived from MFF and visual analysis was computed for sex and grade separately. The direction and general magnitude of these correlations were similar for boys and girls in the two grades (see Footnote 7). Trials to criterion on the learning phase of the visual-analysis tasks were unrelated to recognition of the components or to MFF scores, and number correct on MFF was highly related to total errors. Trials to criterion and number correct on first attempt on MFF were eliminated from further statistical analyses.

In order to assess the relation between reflection and visual analysis, and the generality of the early measure of reflection (DRT) to the more recent measure (MFF), intercorrelations were computed among the major variables derived from Study 3 and the present study. Complete data on all tests were available for 30 younger boys and 30 older boys; 28 younger girls and 25 older girls. The 16 variables were derived from CST, DRT, MFF, and visual analysis tests and the mean scaled score on the information, vocabulary, and similarities subtests of WISC. The latter measure was an index of verbal skills. The matrix of coefficients appears in Table 7 for each of the four groups.

Stability of a Reflective Attitude. The two DRT response time measures were each moderately predictive of response time on MFF 1 year later (average $r = .44$, $p < .001$ with DRT I; $r = .34$, $p < .001$ with DRT II). The error scores on DRT I and II were less consistently related to MFF errors than the response times, and the generality was best for the younger boys and the older girls. The average correlations between major errors on DRT I or II and MFF errors were .28 ($p < .01$) and .40 ($p < .001$). As expected, there was a high-negative relation between MFF errors and response time (r's $= -.66$ and $-.65$ for boys; r's $= -.47$, $-.60$ for girls). The remarkable consistency of a reflective disposition was evidenced by the fact that response time on DRT II predicted errors on MFF 1 year later (average $r = -.29$; $p < .01$). Finally, response time to MFF was minimally related to verbal skills (average $r = .11$).

Significance of Visual Analysis. The scores on the first transfer task were the primary index of the spontaneous tendency to analyze the geometric designs. For after *S* had been exposed to the first test he became aware of the necessity to attend to the element and ground components of the original design. The scores on the second task reflected, in part, the ability to profit from earlier learning.

Correct recognition of the element components on Task 1 was related to analytic concepts (average $r = .23$; $p < .05$), low major errors on DRT I (average $r = -.25$; $p < .01$), and low errors on MFF (average $r = -.23$; $p < .05$), but was independent of response time on DRT I or MFF (average $r = .01$, $.13$) and verbal skills (average $r = .09$).

Reflection was independent of visual analysis, yet each of these variables contributed variance to the more complex products of analytic concepts and recognition errors. A multiple correlation of .56 obtained for older girls when analytic concepts was the criterion and correct recognition of elements and response time to CST were individual predictors. This coefficient is to be contrasted with the correlations of .45 and .39 for the individual predictors with analytic concepts. When major error score on DRT I was the criterion and response time and recognition of elements were the predictors, the multiple coefficient was .52 for younger boys and .62 for older girls. When MFF error score was the criterion, the multiple coefficient was .73 for younger boys. Thus, response time and visual analysis each contributed unique variance to recognition errors and analytic concepts. Each of these variables was relatively independent of verbal ability, suggesting that they are basic cognitive dispositions.

It is of more than passing interest to note that response time on the transfer series of the visual-analysis task (the time *S* took to

TABLE 7

INTERCORRELATIONS AMONG CONCEPTUAL VARIABLES

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Younger subjects																
1. CST, Analytic concepts	—	−.26	−.17	−.05	−.28	−.13	.10	−.28	−.04	−.23	.01	.44	.02	.47	.51	.23
2. DRT I, Major errors	−.52	—	.78	−.39	.60	.67	−.38	.59	−.50	−.08	−.36	−.35	−.40	−.30	−.42	−.28
3. DRT I, Minor errors	−.36	.78	—	−.29	.52	.55	−.25	.45	−.42	−.15	−.21	−.21	−.31	−.07	−.27	−.19
4. DRT I, Response time	.47	−.43	−.46	—	−.41	−.35	.75	−.15	.26	−.01	.13	.05	−.10	.20	−.01	.03
5. DRT II, Major errors	−.55	.56	.31	−.33	—	.50	−.41	.48	−.37	.14	−.15	−.19	−.06	−.06	−.32	−.11
6. DRT II, Minor errors	−.47	.43	.28	−.21	.64	—	−.38	.63	−.65	−.06	−.20	−.13	−.35	−.37	−.53	−.27
7. DRT II, Response time	.37	−.36	−.37	.54	−.24	−.27	—	.08	−.01	.04	.01	−.08	.11	.16	.19	−.11
8. MFF, Errors	−.21	.09	−.09	.00	.53	.52	−.23	—	−.66	.08	−.28	−.39	−.25	−.33	−.28	−.53
9. MFF, Response time	.29	−.27	−.21	.48	−.23	−.15	.44	−.47	—	−.10	.29	.17	.21	.15	.22	.36
10. Visual Analysis I, Ground correct	−.24	−.25	−.25	−.11	−.07	.15	−.22	.26	−.15	—	.30	.13	.35	.15	.31	−.39
11. Visual Analysis I, Figure correct	−.02	−.15	−.04	.02	−.21	−.02	.05	−.19	.45	.29	—	.49	.43	.35	.42	−.14
12. Visual Analysis I, Element correct	−.13	.02	−.03	−.09	.16	−.11	−.34	−.13	−.13	.13	−.35	—	.37	.47	.49	.16
13. Visual Analysis II, Ground correct	.20	−.21	−.18	−.02	−.48	−.48	.33	−.44	.30	.01	.32	−.10	—	.25	.52	.23
14. Visual Analysis II, Figure correct	.09	−.09	−.04	−.24	−.18	−.40	−.18	−.36	.14	−.15	.41	.01	.39	—	.49	.25
15. Visual Analysis II, Element correct	.14	.04	.03	−.02	.03	−.09	−.11	−.21	.25	.07	.17	−.05	.21	.20	—	.02
16. WISC, Verbal skills	.34	−.44	−.43	.14	−.44	−.32	.14	−.28	.22	.14	.14	.09	.42	.22	−.13	—
Older subjects																
1. CST, Analytic concepts	—	−.44	.02	.32	−.36	.01	.16	−.04	−.05	.16	.08	.10	.03	.23	.08	.30
2. DRT I, Major errors	−.32	—	.08	−.11	.44	−.02	.01	−.02	.31	−.26	.01	−.21	−.17	−.07	−.05	−.38
3. DRT I, Minor errors	−.29	.68	—	−.21	.41	.43	−.07	.08	.09	.12	.02	.06	−.12	.09	−.17	−.21
4. DRT I, Response time	.16	−.51	−.49	—	−.14	.00	.51	−.41	.42	−.23	−.08	−.07	−.43	−.12	−.18	.08
5. DRT II, Major errors	−.37	.84	.64	−.51	—	.32	−.16	04	.09	−.10	−.23	−.27	−.16	−.19	.01	−.18
6. DRT II, Minor errors	−.11	.65	.59	−.48	.68	—	−.35	.01	.05	−.09	−.16	.12	.03	−.12	−.08	24
7. DRT II, Response time	.34	−.34	−.47	.71	−.31	−.24	—	−.42	.41	−.22	−.17	−.04	−.25	−.13	−.13	−.40
8. MFF, Errors	−.18	.35	.59	−.43	.50	.38	−.49	—	−.65	.05	−.06	−.25	−.01	−.20	.21	.10
9. MFF, Response time	.30	−.33	−.34	.56	−.37	−.48	.45	−.60	—	−.09	−.12	.09	.08	.00	−.15	−.13
10. Visual Analysis I, Ground Correct	.04	−.21	−.07	.14	−.28	−.20	−.02	−.06	.05	—	.59	.44	.55	.28	.25	.09
11. Visual Analysis I, Figure correct	.29	−.28	−.18	−.03	−.52	−.21	−.14	−.14	.13	.37	—	.53	.24	.50	.25	.05
12. Visual Analysis I, Element correct	.45	−.41	−.11	.12	−.49	−.49	.18	−.11	.36	.00	.30	—	.33	.49	.05	−.06
13. Visual Analysis II, Ground correct	−.14	−.38	−.15	.40	−.35	−.44	.17	−.43	.46	.03	.16	.40	—	.13	.26	.18
14. Visual Analysis II, Figure correct	−.40	−.05	−.01	.12	−.03	−.27	−.05	−.10	.08	.19	.15	−.10	.32	—	−.13	.16
15. Visual Analysis II, Element correct	.29	−.23	−.20	.38	−.34	−.31	.57	−.36	.50	−.17	−.03	.20	−.03	.05	—	.33
16. WISC, Verbal skills	.06	−.47	−.37	.07	−.56	−.29	−.06	−.40	−.03	.21	.30	.17	.16	.01	.02	—

Note.—In the upper portion of the table younger boys ($N = 30$, $r = .35$, $p < .05$, two tailed) are to the right and above the diagonal while younger girls ($N = 28$, $r = 37$, $p < .05$, two tailed) are to the left and below the diagonal.

In the lower portion of the table older boys ($N = 30$, $r = .35$, $p < .05$, two tailed) are to the right and above the diagonal while older girls ($N = 25$, $r = .39$, $p < .05$, two tailed) are to the left and below the diagonal.

decide what nonsense syllable to apply to the components of the design) was positively related to response time on MFF ($r = .68$ for Task 1, and $r = .33$ for Task 2). A conceptual tempo variable—the tendency to delay before answering—operated not only in situations in which the alternatives were all visually present (as in MFF), but also in problems in which *S* had to select one of four responses generated from imagery. The common process in these two task situations was the selection of one response from a set of simultaneously available alternatives.

STUDY 6

Previous studies have presented convincing evidence for the pervasiveness and significance of a decision-time variable. To postulate a psychological dimension carries a responsibility for inquiring into the possible bases for differences in this predisposition. One variable that might be relevant is anxiety generated by the child's expectation of rejection or disapproval from *E*. The effect of experimenter rapport tends to be minimal when a task is moderately difficult and interesting and maximal when a task is too easy. Tasks like DRT or MFF are difficult, but not frustrating, and seem to hold the interest of the children. Thus, experimenter rapport should have a minimal effect on performance on these tests. It seemed appropriate, nevertheless, to investigate the possible effect of this variable. For it could be argued that apprehension over acceptance by *E* would lead most children to modify their behavior in order to reduce this particular source of anxiety. There are at least two kinds of behaviors that might serve this defensive function. The child might respond more quickly because he was less able to tolerate the period of silence between the presentation of the problem and his production of a solution. An alternative argument assumes that anxiety over rejection would increase the child's need to obtain *E*'s approval, and to make potential failure more unpleasant than it ordinarily would be. The child might become more reflective under these conditions in order to insure success.

It is reasonable, therefore, to argue that *E*'s acceptance might lead either to increased or decreased reflection. This study assessed the differential effect of impersonal versus emotionally reassuring testing conditions on instruments tapping an impulsive versus a reflective attitude.

Procedure

The *S*s were 60 boys and 60 girls in the third grade of a public school. Children were paired on sex and IQ and one member of the pair was assigned to the "impersonal" testing group; the other to the "reassuring" testing group. One male *E* was used for all subjects. Under the impersonal testing conditions designed to create anxiety over experimenter acceptance *S* was told to sit quietly at a table for a little while. The *E* then worked at another table for 2 minutes and did not interact with the child. The *E* neither smiled nor talked to *S* during the test administrations except to tell him whether he was correct or incorrect on a test item. Social interaction was minimal and *E* displayed no facial or verbal signs of warmth or acceptance.

Under the reassuring testing conditions *E* spent the first 2 minutes chatting with *S* about his hobbies and interests, and tried to establish a friendly relationship with him. The *E* smiled often during the testing administrations and warmly praised *S* when the latter was correct.

Administration of Tests.

1. DRT—The DRT was administered under conditions described earlier.
2. Story Recall—The *E* read a paragraph of 106 words to *S* with the prior instruction that *S* would have to repeat the paragraph. The paragraph contained several incongruous elements and specific details. The purpose of this task was to assess the differential effect of the two testing conditions on immediate recall. The story was constructed to contain 15 critical-meaning units, and the child's score was the number of units recalled.
3. MFF—The MFF was administered under conditions described earlier.
4. Haptic visual matching (HVM)—This new test was designed to measure the impulsivity-reflection dimension with a cross-modal task—the haptic and visual modes. The child first explored tactually a three-dimensional wooden form to which he had no visual access. After this exploration *S* selected from a visual array containing five similar stimuli the one pattern that was an identical representation of the form he explored haptically. This task was devised in order to inquire whether the dimension of impulsivity derived from completely visual tasks (DRT or MFF) would generalize to a situation in which the initial comprehension of the stimulus was obtained through a different modality. A second rationale was that this test furnished an objective index of a scanning time. For the time *S* took to explore the wooden form could be regarded as a measure of the amount of time taken to comprehend

the new stimulus. It was hoped that this task would furnish information on the following question: Is the occurrence of recognition errors due primarily to fast response times in the final selection process, or does amount of scanning of the original stimulus contribute some variance to error scores?

The task contained 20 stimuli, 10 of which were geometric forms; the remaining 10 were objects with which the child was familiar (tree, child, hand, airplane, automobile, pipe, scissors, shirt, cat, pig). The child was told to palpate the wooden form with his fingers as long as he wished and to withdraw his hand from in front of a black curtain when he was finished. He was then shown a card illustrating five "ink-line" drawings and asked to select the visual form that corresponded to the one he had palpated. The *E* recorded palpation time of the standard, response time to the first selection, and number of errors for each item. Figure 9 illustrates the visual arrays for two items.

These four tests furnished 18 variables for analysis. Intelligence might have interacted with the two testing conditions, and each of the four groups (two sexes and two testing conditions) was divided into high- and low-intelligence groups based on scores from CTMM which had been gathered by the school several months earlier. The two intelligence groups should be regarded as normal versus bright normal, for only two children had IQ scores below 90.

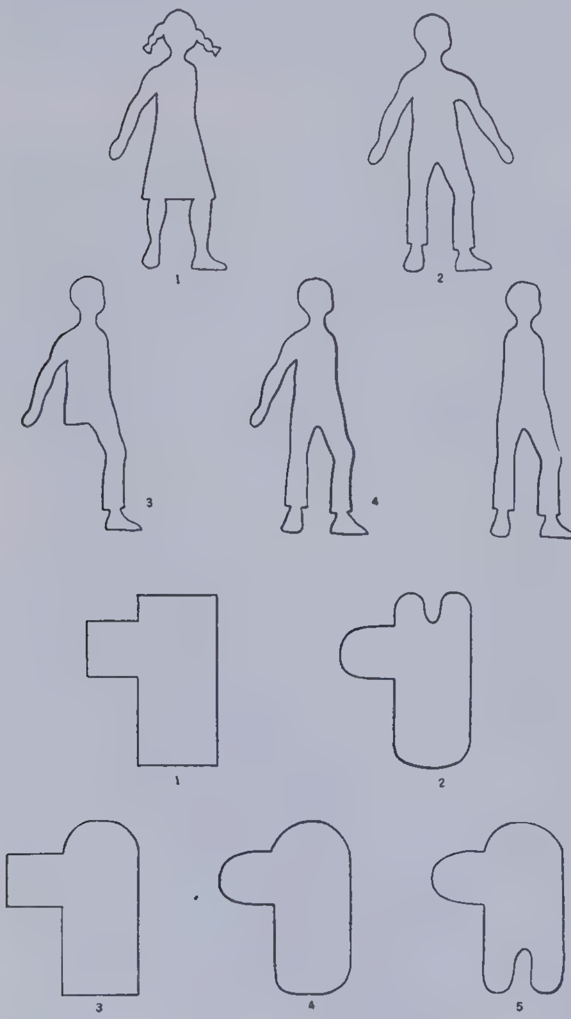

FIG. 9. Sample items from HVM.

Results

Analyses of variance were performed for each of the variables, and the main results are summarized below (see Footnote 7).

Effect of Testing Conditions. There was no significant effect of impersonal versus reassuring testing conditions on any of the three error variables. Moreover, the only response-time variable for which testing conditions had a significant simple effect was response time on HVM, with impersonal conditions producing longer response times. But this effect did not hold for response times to MFF or DRT. Finally, testing conditions had no effect on story recall. In sum, testing conditions had a minimal effect on both response time and error scores, supporting the earlier statement that warm or cold rapport is not particularly relevant for the reflection dimension when the test situations are moderately challenging and of interest to the child.

Intercorrelations among the Variables. In order to assess the consistency of response time and errors for the three tasks, intercorrelation matrices were computed for each of the four groups with 30 *S*s in each group (i.e., two sexes by two testing conditions). The direction and magnitude of the correlations were remarkably similar for both testing conditions, and average r's (z' transformations) were computed for *S*s in the two testing conditions with sexes kept separate. The matrix of coefficients for the nine major variables appears in Table 8.

These data, like those presented earlier, present a picture of consistency for both response time and errors across the varied tasks. Errors on DRT, MFF, and HVM were positively correlated for both sexes (r ranged from .33 to .52, all significant at $p < .01$). Similarly, response times to DRT, MFF, and HVM were highly intercorrelated (r ranged from .48 to .82), the correlations being higher for females than for males. As usual, the intertask consistency for response times was greater than the consistency for errors.

Response times were inversely correlated with error scores for all tests, but the relation

TABLE 8

INTERCORRELATIONS AMONG CONCEPTUAL VARIABLES
(Average r for two testing conditions)

Variable	1	2	3	4	5	6	7	8	9
1. DRT, Errors	—	.53	.33	−.28	−.33	−.35	−.39	−.13	−.30
2. MFF, Errors	.49	—	.52	−.22	−.57	−.51	−.35	−.35	−.47
3. HVM, Errors	.44	.48	—	.07	−.15	−.28	−.50	−.37	−.37
4. DRT, Response time	−.33	−.34	−.25	—	.48	.57	.18	−.22	.01
5, MFF, Response time	−.32	−.51	−.43	.79	—	.59	.32	.07	.05
6. HVM, Response time	−.38	−.45	−.47	.75	.82	—	.56	−.09	.14
7. HVM, Palpation time	−.35	−.42	−.40	.22	.43	.55	—	.24	.08
8. Story Recall	−.14	−.26	−.30	.00	.10	.05	.14	—	.29
9. IQ (CTMM)	−.25	−.21	−.35	−.01	.15	.03	.00	.45	—

Note.—Boys are to the right and above the diagonal ($N = 60$) and girls are to the left and below diagonal ($N = 60$). $r = .25$ for $p < .05$, two tailed; $r = .33$ for $p < .01$, two tailed; $r = .41$ for $p < .001$, two tailed.

was best for MFF. Additional data from several other samples also revealed that the negative relation between response time and errors was better for MFF than for DRT or HVM. The MFF task is more difficult than the other two tests and this is one reason for this relationship. Once again, the relation between errors and response time held across tasks. For DRT errors were as highly associated with response time on HVM (r's $= -.35$ and $-.38$) as they were with response time on the DRT itself (r's $= -.28$ and $-.33$), indicating the pervasiveness of a decision time variable.

Palpation time on HVM, the time S took to explore the wooden form, was highly related to HVM response time (r's $= .56$ and $.55$). Children who responded quickly took less time to explore the standard. Moreover, palpation time predicted DRT errors (r's $= -.39$ and $-.35$) and MFF errors (r's $= -.35$ and $-.42$) and, for boys, was a better predictor of HVM errors than HVM response time ($r = -.50$ versus $-.28$).

Relationship to IQ. There were low-negative correlations between IQ score and errors on each of the three tasks (r ranged from $-.21$ to $-.47$), but no relationship between response time and IQ (r ranged from $-.01$ to $.15$, all nonsignificant). Thus, recognition errors were jointly influenced by the multiple processes implied by high IQ and by decision time. Some of the basic variables implied by high IQ score are special problem-solving skills, rich vocabulary resources, confidence in one's ability to solve problems, and the motivation to do well on intellectual tasks. The multiple correlations with DRT, MFF, or HVM errors as criterion, and response time and IQ as individual predictors were high. The multiple coefficient for MFF errors was .72 for boys and .54 for girls; for DRT it was .41 for boys or girls. The multiple correlation for HVM was slightly higher for boys if palpation time, rather than response time, was the predictor. The coefficients were .60 for boys and .53 for girls when palpation time was used; the coefficients were .46 for boys and .58 for girls when response time was used. When intelligence and response time were jointly taken into account it was possible to account for approximately twice as much variance in error scores as when only one of these variables was used as a predictor.

Discussion

The minimal effect of impersonal versus reassuring testing conditions upon response time and recognition errors suggests that these predispositions are not easily changed by experimenter rapport and are fundamental response tendencies in the child. The consistency of recognition errors and decision times across three different tasks is another demonstration of the pervasiveness of an individual difference variable which might be called "conceptual tempo."

The palpation time scores for HVM indicate that Ss who explore the stimulus rapidly are also apt to respond quickly and are likely to make more errors. It would be important to determine if visual scanning times on MFF or DRT, the analogue of palpation time, manifest the same relationship to response time and errors as palpation time does on HVM.

STUDY 7

The negative relation between analytic concepts and impulsive offering of incorrect solutions is further supported by data from a small group of Fels children.

Procedure

Subjects. The *S*s were 34 boys and 22 girls from the Fels Research Institute's population (age range from 7-1 to 11-4). Each *S* was seen individually by a female *E*[11] for two 1-hour sessions and administered the following test battery during the first session.

Administration of Tests.

1. CST—Each child was administered CST and the variable scored was the number of analytic responses.
2. Embedded Figures Test (EFT)—Each child was administered 10 items from the Witkin Embedded Figures Test using standard instructions (Witkin et al., 1962). The major variables scored were (*a*) total time to solution and (*b*) the total number of incorrect solution hypotheses.

The tests administered during the second session were as follows.

3. Word-association test—Each *S* was administered the 40-item word-association test described in Study 1. The major variables scored were frequency of coordinate nouns, coordinate verbs, and antonyms to adjective stimuli.
4. Figure-ground visual-analysis task—Each *S* was administered a visual-analysis task similar to that described in Study 4 in which only two components with figure and repetitive background were used, but five rather than four geometric designs were presented.
5. PDT—Each *S* was administered PDT as described in Study 4. The *S* was allowed to continue responding to each of the 30 items until he located the correct difference, or for a maximum of 2 minutes. The major variable was the total number of incorrect hypotheses offered.
6. Transfer Trial 2: Visual-analysis task—Each *S* was again presented with each of 10 figure or ground variants derived from the original geometric designs.

Results

A total of 11 variables was derived from these five tests, and these scores were intercorrelated (see Footnote 7). The major relationships can be summarized briefly. For boys analytic concepts were negatively related to number of incorrect hypotheses on PDT ($r = -.32, p < .10$), and EFT ($r = -.49, p < .01$). These data are in essential agreement with the results of earlier studies in supporting the inverse association between analytic concepts and the production of incorrect responses prior to solution. It is important to note that analytic concepts were not highly related to the ability to solve EFT ($r = -.27$ with solution time, not significant). An analytic attitude on CST was more closely related to a strategy of problem solving (i.e., reflection on the adequacy of alternative answers) than to the ability to solve this kind of problem (i.e., detect the disguised stimulus). Since Witkin and his colleagues regard solution time on EFT as the primary index of field independence, the present construct of reflection differs in meaning from Witkin's concept of field independence.[12]

There was a moderately positive relation between analytic concepts and correct labeling of figural elements on the transfer trials (r's $= .23$ and $.28$), and this finding supports earlier results. The two error scores (i.e., number of incorrect responses on PDT and EFT) were moderately related to each other ($r = .39$, $p < .05$), and each had similar correlation patterns with the other variables. For boys EFT errors were negatively related to correct recognition of the figural elements (r's $= -.52$ and $-.47$ for Transfer Trials 1 and 2, $p < .01$).

The pattern of relationships for girls was somewhat different than that obtained for boys. Analytic concepts were not highly related to errors on PDT or EFT, but were positively related to recognition of both figure and ground components for transfer Trial 2 ($r = .39, p < .10$; $r = .52$; $p < .05$). As with boys, errors on PDT and EFT were positively correlated ($r = .51, p < .05$), and PDT errors were negatively related to correct recognition of the figural components. Moreover, errors on PDT and EFT were each associated with infrequent production of coordinate nouns, verbs, or antonyms. Thus, an impulsive approach to PDT and EFT was associated with syntactic immaturity for the girls, as infrequent analytic concepts on CST were associated with syntactic immaturity for the first and second grade boys in Study 1.

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[11] The authors are indebted to Carolyn Cermele and Alice Rabson who administered these tests.

[12] In an unpublished investigation of 22 women between 50 and 60 years of age, we found no relation between accurate recognition of the figural component in the visual-analysis task and solution time on EFT, but a significant negative relation between recognition of the figural component and number of incorrect solutions on EFT ($p < .05$).

The results are in essential agreement with earlier work and strengthen the basis for postulating the two dimensions of reflection-impulsivity and visual analysis.

STUDY 8

Observation of reflective and impulsive boys during the testing sessions suggested that the latter group typically displayed more restlessness and greater distractibility. The sections that follow describe three attempts to obtain more systematic data on the relation between motor restlessness or distractibility and conceptual impulsivity.

Part A

Subjects. The *S*s represented extremes on the distribution of analytic concepts and recognition errors on DRT. The *S*'s were selected from the 72 boys and 63 girls seen in Study 3 who had been administered CST and DRT. Since analytic concepts were related to low error scores on DRT, two groups were composed. The *S*'s in the low-impulsive group were above the median on the distribution of analytic concepts and below the median on the distribution of total errors on DRT I. The *S*s in the impulsive group were below the median on analytic concepts and above the median on DRT errors. This dichotomy yielded 21 boys and 13 girls classified as nonimpulsive and 22 boys and 20 girls classified as impulsive.

Procedure. Each child was observed in his classroom from 8:45 until 10:45 each morning. The observer coded *S*'s behavior only during those times when *S* was seated at his desk and the classroom situation called for attention to a school task. The observer checked the occurrence of each of five behavioral categories during successive 10-second periods. Only one check was permitted for each variable during any 10-second period, but it was possible for all five variables to be checked during a single period. Approximately 60 minutes of coded observational data were obtained on each *S* during each 2-hour session, and 70 of the 76 *S*s were observed on two separate occasions yielding 2 hours of observational data. The scores consisted of the average values for the two sessions combined for the following variables: (*a*) leg movements, (*b*) arm movements, (*c*) trunk movements, (*d*) attention to task, and (*e*) distractibility (i.e., child looks away from the task). The interrater reliabilities for these categories were obtained by having two observers independently code 72 separate 10-minute sessions. The reliabilities (product moment) for each of the five categories ranged from .84 to .96 with a median reliability coefficient of .94.

Results. The variable of primary interest was the ratio of time spent attending to a task divided by time spent distracted. This ratio ranged from .6 to 14.9 (median 3.0) for boys, and from .7 to 3.7 (median 1.9) for girls. The stability of this ratio from Observational Session 1 to Session 2 was moderate ($r = .34$ for boys and .68 for girls, p's $< .05$ and $< .001$). The ratio of task attention to distractibility discriminated the impulsive and nonimpulsive children. The mean for the nonimpulsive boys was 3.9; the mean for the impulsive boys was 2.7 ($p < .05$). For the girls the corresponding mean scores were 2.2 and 1.7 ($p = .06$). The number of limb or trunk movements while seated at a desk did not discriminate the two groups.

Extreme scores on this ratio were excellent predictors of the impulsivity dimension for the boys. Ten boys had ratios of 4.0 or higher on both observational sessions and eight *S*s in this group were nonimpulsive on the tests. It should be noted that the ratio of task attention to distraction was not as highly related to response time on DRT as it was to error and analytic concept scores. Thus, the derived variables of analytic concepts and recognition errors were better predictors of the classroom behavior than the decision time variable.

Impulsive *S*s were likely to display momentary lapses of attention during involvement in a school task; they were more likely to look out the window, gaze at a peer, or orient to a sound during a period when they were working at an academic task. These behavioral observations are in complete agreement with the problem-solving behavior displayed by the children in the laboratory setting. The reflective children seemed capable of greater concentration; they showed less distractibility during the conceptual tasks.

Additional observations of the free-play behavior of the boys supported these classroom observations. Each of the 43 boys in the above study (each was extreme on the impulsivity dimension) was observed for 10 minutes during a school recess period on the playground. Each time the boy initiated gross motor activity (ran, jumped, played on gross motor apparatus) a stopwatch was started. When *S* stopped the activity the watch was stopped. The total time recorded at the end of 10 minutes was an index of the time spent in gross motor activity. There were no differences in activity between second and third grade boys and the data from both grades were combined. There was a significant difference between the two groups with the impulsive *S*s spending more time in gross motor activity than the nonimpulsives (1.8 minutes versus 3.2 minutes, $p < .05$). These results agree with earlier findings indicating more frequent gross motor behavior by impulsive boys (Kagan et al., 1963).

Part B

Behavioral observations on the sample of Fels boys described in Study 7 support the association between spontaneous displays of task unrelated gross motor behavior and an impulsive attitude.

Procedure. Twenty-seven of the 34 boys between 7 and 11 years of age who were given CST in Study 7 had been observed extensively from birth to age 8 in the child's home and in the Fels experimental nursery school. Most *S*s were observed for a half day semiannually in the home, and a description of their behavior was prepared after the visit. Beginning at 3 years of age each child was brought to the institute once or twice a year for 2 weeks during which he participated in a small play group of 6–9 children of his own age. The *S*'s behavior was observed systematically, and a lengthy description of his behavior was prepared. These observational protocols were divided into two sets covering birth to 4 years of age and 4–8 years of age. A senior psychology student was trained to rate these protocols for four variables:[13] (*a*) gross motor activity, (*b*) time alone involved in task mastery, (*c*) retaliation to attack by same-sex peers, and (*d*) instigation of physical aggression to same-sex peers. The student made two sets of ratings (on a 7-point scale) for these four variables. One set of ratings was made for age 0–4 and the other for age 4–8. The rater had no knowledge of *S*'s performance on the conceptual tasks while she was making her ratings. No scores were available for 10% of the ratings because of insufficient data. Independent ratings of this material by one of us (JK) indicated satisfactory interrater reliability (r ranged from .85 to .93 for the four variables).

The number of analytic concepts on CST was available for each child, and each *S* was assigned to a high- or low-analytic group depending on whether his score fell above or below the median for his age group. This dichotomy yielded 13 high-analytic and 14 low-analytic boys. The mean scores for the two groups on each of the four behavioral variables for ages 0–4 and 4–8 were compared.

Results. The results are in complete accord with those found on the sample of second and third grade boys, and with data reported earlier (Kagan et al., 1963). Boys high in analytic concepts, in contrast to those with few concepts, displayed less spontaneous gross motor behavior during age 4–8 and more solitary task oriented behavior during both ages 0–4 and 4–8 (p's $< .10$, $< .05$, $< .05$). There was no association, however, between instigation of aggression or retaliation and analytic concepts. The fact that ratings of solitary involvement in task mastery during the first 4 years of life predicted analytic concepts 4 years later suggests that some of the critical antecedents for this conceptual category are present early in development.

An earlier and more extensive investigation of behavioral continuities among Fels subjects (Kagan & Moss, 1962) reported that ratings of hyperkinesis during the period 3–6 years of age predicted phenotypically similar behavior during ages 6–10 and 10–14. Moreover, hyperkinesis during age 6–10 was inversely correlated with ratings of involvement in solitary intellectual mastery among adult men ($r = -.37$, $p < .05$). The fragile empirical link between behavior during the first 5 years and an analytic attitude during the school years suggests that constitutional variables and/or early learning influence this class of conceptual responses.

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[13] The authors are indebted to Eva Manoff for ratings of these observational data.

Part C

A final set of data based on respiratory patterns to episodes calling for attention corroborates the inverse relation between restlessness and distractibility, on the one hand, and an analytic attitude on the other.

Procedure. Fifty-five of the 62 boys in Study 1 were seen for a 45-minute experiment during which heart rate and respiration were monitored for 16 1-minute episodes. Four of the episodes required *S* to attend to a simple visual or auditory stimulus; 4 required mental elaboration; with 8 1-minute rest periods interposed between each of these work episodes. A complete description of the procedure appears in another report (Rosman, 1962). A brief summary of the procedure follows.

Each *S* sat beside a female *E* (BLR) who administered the following procedures:

1. Rest (RST).
2. Color wheel (COL)—The *S* was asked to watch a red sector in a color wheel while the entire wheel revolved for a 90-second period.
3. Rest (RST).
4. Make-up-stories (STY)—The *S* was given a picture for 10 seconds after which it was removed, and *S* was asked to think up a story silently during the remaining 20 seconds. This procedure was repeated three times for a total of 90 seconds.
5. Rest (RST).
6. Word association (WRD)—The *S* was read a word or short phrase and asked to think up a picture silently to the word or phrase.
7. Rest (RST).
8. Stick-on-floor (STK)—The *S* listened to the sound of a stick hitting the floor at irregular intervals.
9. Rest (RST).
10. Make-up-story (STY)—The *S* was given three different pictures as in Number 4 above.
11. Rest (RST).
12. Listen to noise (NOI)—The *S* was asked to attend to increases in the intensity of the masking noise that was present in the room. The increases were brief and irregularly spaced over a 90 second period.
13. Rest (RST).
14. Attend to light (LGT)—The *S* was asked to watch momentary increases in the intensity of light in the room.
15. Rest (RST).
16. Make-up-story (STY)—The *S* was given three new pictures and asked to make up stories as in Number 4 above.

For each of the 16 episodes, four basic variables were coded: respiratory period, standard deviation of respiratory period, average cardiac period, variability of the cardiac period. The major results were that under conditions of attention (COL, STK, NOI, LGT), in contrast to the contiguous rest periods (RST), respiratory variability was markedly less and cardiac rate markedly lower for the majority of the children (Kagan & Rosman, in press). However, boys high on analytic concepts displayed this general effect even more clearly than less analytic children. Figure 10 shows the average standard deviation of respiratory period for high- and low-analytic boys (based on median split) over the 16 episodes. Each value is based on the first 20 respiratory cycles in each of the 16 episodes.

Results. Respiratory variability was lowest for all *S*s for those situations in which the child had to attend to visual or auditory signals (COL, WRD, STK, NOI, LGT). But analytic boys breathed at a more regular rate for the first eight episodes than the less analytic ones ($p < .01$). The negative relation between analytic concepts and respiratory variability during an attention period was highest for the color wheel (COL; $r = -.38$, $p < .01$). The major causes of increased respiratory variability were restless movements of the trunk, sighing, and lack of attentiveness to the test stimuli. Observer ratings of restlessness and distractibility during the experiment suggested that the analytic boys were less restless and more attentive. The respiratory data furnished more elegant and objective support for these cruder observations. In sum, on the playground, in the classroom, or in a restrictive laboratory situation, analytic boys were less restless, less distractible, and less active than their nonanalytic counterparts.

An unpublished study by Irving Sigel furnishes additional support for these conclusions. Sigel presented pictures to 22 boys and 22 girls of kindergarten age who came from upper-middle-class families. Each of the 20

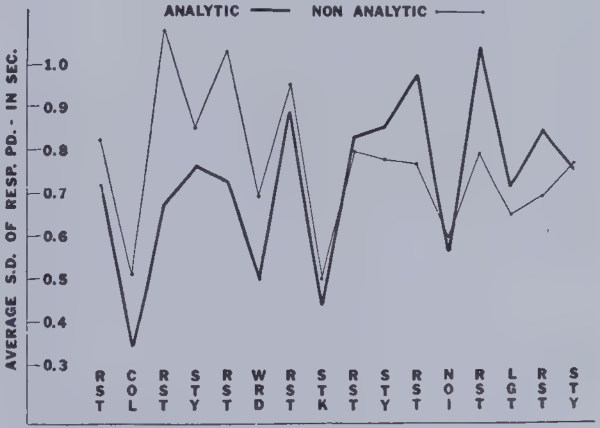

Fig. 10. Respiratory variability for analytic and nonanalytic boys.

pictures displayed a standard and three choice stimuli. The child was asked to select one of the three choice stimuli to "go with" the standard. The children's school behaviors were rated by their teachers. The boys who produced analytic conceptual groupings (i.e., their selections were based on similarity in some differentiated and objective component between the standard and one of the choice stimuli) were rated as more controlled emotionally than the less analytic boys. The correlation between "emotional control" and analytic concepts was .45 ($p < .05$) for boys, but $-.20$ for girls. These data on a group of upper-middle-class kindergarten children are consonant with those reported here for a more representative group of second and third graders. The lack of a relationship between emotional control and analytic concepts among girls supports previous suggestions that the relationship among impulsivity, restless motor behavior, and analytic concepts is somewhat different for boys than for girls.

DISCUSSION

These studies have been concerned with four related questions: the behavioral significance and basic determinants of analytic concepts, and the generality and stability of reflection impulsivity and visual analysis.

Meaning of Analytic Concepts

Although the empirical work began with investigations of analytic concepts on CST, it has become clear that this variable has multiple antecedents, two of which are reflection and visual analysis. When a set to reflect was created experimentally (Study 2), number of analytic concepts was increased. Moreover, long response times on CST and DRT were positively correlated with analytic responses. The role of visual analysis in facilitating analytic responses was supported directly in Studies 4 and 5, and indirectly in the positive association between analytic groupings and initially correct selection of the correct variant on DRT. When number of analytic concepts was the criterion and response time to CST and correct recognition of elements on visual analysis were separate predictors, the multiple-correlation coefficient reached .56 for one group of fourth grade girls. The overt behavioral correlates of an analytic attitude, among boys, included a capacity for sustained concentration in intellectual tasks, absence of an extreme degree of task irrelevant gross motor activity, and inhibition of impulsive-solution hypotheses in varied problem tasks.

In the light of all the data the following interpretation of the analytic concept is offered. The most obvious way to pair stimuli on most of CST items involves a thematic or functional relationship between two objects. The dominant association to the watch, man, and ruler is a functional linking of the watch and man, or the ruler and man; the dominant association to the house, matches, and pipe is a functional bond between the matches and pipe. If the child is to produce an analytic concept, he must suppress these initially strong, "popular" associations and reflect over alternative responses. If, in addition to a reflective attitude, he also has a predilection for visual analysis, he is likely to produce an analytic concept. Thus, reflection over alternative solutions together with a predisposition to analyze visual arrays are intuitively reasonable determinants of analytic concepts. The empirical data support the intuitive argument. It is to be noted that analytic concepts, visual analysis scores, and indexes of reflection each display a linear increase with age during the school years (Kagan, in press).

Significance of Reflection Impulsivity

A second, and probably more significant, set of findings is contained in the stability and generality of a tendency toward reflection. Long response times on the varied perceptual recognition tasks showed a greater stability over time and more impressive intertask consistency than indexes of an analytic attitude or recognition-error scores. The reliability of response times over a 9-week period was in the high 70's, and there was remarkable generality across tasks as varied as DRT, MFF, and HVM. It is to be noted that the high degree of consistency for response times is limited to this particular kind of problem (i.e., many response alternatives available simultaneously and the correct alternative is not immediately obvious). This consistency should not necessarily occur on tasks with only one alternative or on tasks for which the alternatives are not quickly and simultaneously available. Response times to simple rote questions (e.g., What is your name? What is the month?); to difficult arithmetic questions; or on simple motor-reaction-time tasks should not necessarily correlate highly with each other or with response times on tasks like DRT or MFF.

Reflection is defined semantically as the consideration of alternative solution hypotheses (either classifications or problem-solving sequences) when many alternatives are available simultaneously. Reflection does not refer to delay that is the result of fear of failure, timidity, or inability to generate any solution. The tasks used in this work minimize fear of failure, but further efforts to guarantee this control are necessary.

Significance of Recognition Errors

Recognition errors, like analytic concepts on CST, are multiply determined with reflection as the major variable and visual analysis and verbal skills as secondary factors. Error scores on DRT or MFF were consistently related to verbal ability; whereas, response times were independent of verbal skills. The potpourri of processes implied by the phrase "verbal intelligence" influence quality of performance on problems that do not require complex reasoning operations or rich verbal expression. A verbal intelligence index encompasses a variety of more fundamental factors such as expectancy of task success, availability of verbal labels for unique classification of stimuli, special problem-solving skills and strategies, and motivation to perform well. When a child believes that a problem has a definite answer and requires concentration for success, it is usually the case that a global index of intelligence relates positively to performance score when the sample tested contains an adequate range of IQ scores (e.g., 90–120). The tendency to reflect on alternative solution possibilities is only one problem-solving strategy that has only indirect implications for performance. The important distinction between a reflective strategy and success with a problem was supported by the finding that solution time on EFT, which measures quality of performance, was unrelated to analytic concepts; whereas, generation of incorrect hypotheses on EFT was positively related to an analytic attitude.

Antecedents of Reflection Impulsivity

A tendency toward reflection versus impulsivity displayed a stability over time and a generality across tasks that is unusual for psychological attributes and tempts one to conclude that this disposition is a basic component of a child's behavioral organization. It is critical, therefore, to understand the antecedents of this predisposition. Why are some children more reflective than others? Three possibilities deserve exploration: constitutional predispositions, degree of involvement in tasks, and expectation of failure.

There is growing evidence suggesting that one of the possible consequences of minimal brain damage during the perinatal and early postnatal periods is increased restlessness and distractibility during the preschool and early school years. It is possible that extreme impulsivity at age 6 is a partial consequent of subtle cerebral insult early in life. The positive relation between level of gross motor activity during ages 4–8 and nonanalytic concepts at age 8 suggests that the basic determinants of impulsivity may be present early in development. Biological processes, unrelated to CNS insult, could also account for large individual differences in activity level and, as an epiphenomenon, conceptual impulsivity. Schaefer and Bayley (1963) found that very active 10-month-old boys were rated as low on attentiveness during the period 27–96 months of age. Preliminary results from an intensive longitudinal study of infant activity and attention at the Fels Institute suggest that vigor of motor activity and degree of sustained attention to visual stimuli are inversely correlated, and each is moderately stable from 8 to 56 weeks of age. Moreover, the boys were more active and less attentive than the girls to visual presentations of pictures and blinking light patterns. The evidence is still thin, but strong enough to support the conjecture that some of the basic determinants of conceptual reflection versus impulsivity can be previewed in the activity and attentional behavior of the infant.

A second set of psychological factors that might influence the reflection dimension is degree of involvement in the task. The child who has high standards of performance should be more likely to reflect on alternative hypotheses. The child who cared less about the quality of his product should be likely to accept his first association on CST and adopt an impulsive trial-and-error strategy to DRT or MFF.

A final hypothesis concerns the child's anxiety over his ability to perform well in the tests of reflection impulsivity. Most of the children appeared to have a desire to do well on the tasks presented and to convince *E* that they were able to perform adequately. Let us look closely at the psychology of the situation the moment *E* presents a DRT item to the child. The child who is anxious about his ability and expects to fail may be unable to tolerate the period of silence that is an inevitable concomitant of response selection. He may fear that the silence will be interpreted as an indication of his inability to provide a correct answer immediately, and in order to reduce this tension he may offer an answer impulsively. The child who is minimally anxious about his ability on these tasks will be less anxious over the possibility that *E* will disapprove of him and will be more able to tolerate the delay between presentation of a problem and his reporting of an answer. Delay in the service of reflection may be facilitated when the child expects success, for this expectation makes it easier to tolerate the silence that accompanies consideration of alternative answers. These three hypotheses are not mutually exclusive and all three might contribute variance to the reflective dimension.

Methodological Implications of Reflection and Analysis

A response to a psychological test—be it an ink blot interpretation, a story to a picture, or the selection of an answer in a multiple-choice inventory—usually involves processing of information and the selection of one best response from a set of alternatives. Motives, conflicts, and defenses are not the only factors that affect the final cognitive product in these test situations. The dimensions of reflection and visual analysis influence the manner in which information is classified and, consequently, the content of the final response. The acknowledgement of individual differences in mode-of-information processing leads one to look at personality test data, for example, through lenses that differ from the conventional kind. To illustrate, Fisher and Cleveland (1958) use an *S*'s ink-blot interpretations as an index of a variable called "barrier response" which is assumed to reflect a person's basic conception of his body. Study of the responses that comprise the barrier score reveals that they often refer to well-delineated objects qualified by descriptive adjectives (e.g., woman with a dress on, man with armor). Previous studies (Kagan et al., 1963) and the data summarized in this monograph indicate that analytic children are likely to produce interpretations that are well delineated and contain adjectives describing physical attributes of objects. Nonanalytic children are more likely to give amorphous responses having minimal articulation and not qualified by descriptive adjectives (blood, ice cream, mashed bug). These latter percepts are called "penetration" responses by Fisher and Cleveland. The occurrence of *barrier* and *penetration* responses may be a function, in part, of the degree of analysis of the ink-blot stimulus and degree of reflection over alternative interpretations and only minimally related to body image.

A second methodological implication of this work touches the validity of the assumption that factor analysis of group-administered tests can yield the basic components of intellective activity. It is difficult to obtain sensitive indexes of response time from group-administered test procedures. The data summarized suggest that the reflection-impulsivity dimension may be a basic variable, but it is not likely that a factor analysis of the data derived from most group administered test batteries would yield a "reflection" factor.

Problem Solving

A final implication of the reflection-impulsivity dimension concerns the gradual establishment of permanent attitudes toward problem solving and strategies of solution with novel-problem tasks. In complex problems with alternate routes to solution reflection upon the probable validity of varied solution sequences is critical for the ease with which success is achieved. The child who does not reflect upon the differential validity of several solution possibilities is apt to implement mentally the first idea that occurs to him. This strategy is more likely to end up in failure than one that is characterized by reflection. For the impulsive child who reaches a *cul-de-sac* in a problem-solving sequence and recognizes he has not solved the problem is likely to become more anxious than he was initially. As a result of the increased anxiety his selection and evaluation of a second solution path is apt to be impaired, and the probability of success attenuated. This maladaptive cycle may become entrenched with time and after 5 years of experiencing the sequence: problem ——→ impulsive selection of invalid solution sequence ——→ failure ——→ anxiety ——→ selection of second sequence . . . ——→ failure . . . etc., the child may gradually withdraw involvement from problem situations and become apathetic or hostile toward intellectual situations.

Relation to Basic Research and Theory

The points of contact between reflection and analysis and the main stream of psychological theory in cognition are still unclear. Witkin and his colleagues (1962) have used solution time on the EFT as an index of the construct of field independence. The data summarized indicate no strong relation between field independence and reflection impulsivity. Experimental psychologists have noted recently that discrimination response time is not only a function of information transmitted (i.e., stimulus uncertainty), but is also determined by response uncertainty (Morin & Forrin, 1963; Seibel, 1963). It is believed that further investigations of response uncertainty will provide an important bridge between the traditionally isolated domains of cognition and personality. For available data suggest that individual-difference variables like motivation, expectation of failure, and hyperkinesis are responsible, in part, for the dramatic variability associated with laboratory studies of response time, perceptual dynamics, and human learning. The data generated by studies in these three substantive areas are influenced, in varying degrees, by *S*'s characteristic strategy in situations with high-response uncertainty.

Theoretical conceptualizations of intellective development have been mainly concerned with the growth and dynamics of mediational systems and cognitive operations (e.g., associational transformations, algorithms, rules of reasoning). Piaget's theorizing, for example, has centered on the characteristics of cognitive structures at different stages of development, and Piaget assumes that differences in these structures explain age differences in cognitive productions. Both European and American psychologists have typically been indifferent to the cognitive phenomena that describe the beginning and end of a problem-solving sequence: the initial coding of information, the selection of a "best" solution hypothesis, and the psychological characteristics of the response the child uses to communicate his answer to a social agent. The reflection and analysis variables are essential aspects of these processes.

This paragraph is an attempt to dilute the authors' tendency to imply that the reflective child was necessarily the better or brighter child. It seems reasonable to assume that efficient learning and performance on varied intellective tasks will sometimes be facilitated by a reflective or analytic approach; sometimes by a more impulsive or less analytic orientation. Indeed, a recent study (Lee et al., 1963) demonstrated this last point clearly. Some of the academic contents children must master require reflection and analysis especially the disciplines with deductive structures such as mathematics and physical science. But mastery and productivity in the humanities, arts, and social sciences can be hampered by an excessively strong reflective orientation. New pedagogical procedures should acknowledge the interactions between the dispositions of the learner and the material, and tailor presentations to the preferred strategy of the child.

SUMMARY

These studies have uncovered two basic cognitive dispositions that appear to have generality and stability: the tendency to analyze visual arrays and the tendency to reflect upon alternative-solution hypotheses in situations where the alternative-response possibilities are available simultaneously. Each of these dispositions contributes considerable variance to the production of the more complex cognitive products of analytic concepts on CST and recognition errors on tasks requiring complex perceptual discriminations (DRT, MFF). The studies upon which these conclusions are based are summarized below.

Study 1

Investigation of first and second grade boys revealed that the production of analytic concepts on CST was positively related to the tendency to inhibit incorrect solution hypotheses on EFT, high scores on the Picture Arrangement subtest of WISC, and the production of articulated ink-blot percepts. However, analytic concepts were unrelated to verbal skills. These findings linked analytic concepts with the tendency to reflect over alternative response possibilities.

Study 2

Second grade children were assigned to one of two experimental groups and administered CST, DRT, and EFT. One group was instructed to respond quickly; the other group was instructed to respond slowly and to reflect upon their answers. Children in the slow-instruction group produced more analytic concepts on CST and made fewer errors on DRT, suggesting that experimental manipulation of the tendency to reflect upon alternative solutions does affect analytic concepts and perceptual-recognition errors in the manner predicted.

Study 3

Second and third grade children were administered CST, DRT, and several related tests in two sessions separated by 9 weeks. There was remarkably high consistency of recognition error and response-time scores across the two administrations on DRT that were separated by 9 weeks. Moreover, there was an inverse relationship between recognition errors and response time. Finally, analytic concepts on CST were inversely related to error scores on DRT and related perceptual discrimination tests.

Study 4

A group of 57 fourth grade boys was administered CST and a measure of visual analysis. There was a positive correlation between analytic concepts and the tendency to analyze the geometric stimuli into distinct figural and background components, indicating that visual analysis was a determinant of analytic groupings.

Study 5

Third and fourth grade *S*s who were seen in Study 3 were administered new tests of visual analysis and reflection impulsivity 1 year later. These scores were correlated with the earlier measures of reflection impulsivity. There was moderately high stability for the reflection-impulsivity dimension over the 1-year period. For response time and error scores on DRT task were related to response time and errors on MFF 1 year later (correlations in the .40's). Correct recognition of the element components in the visual-analysis task was positively related to analytic concepts on CST, negatively related to error scores on DRT or MFF, but independent of response time or verbal ability. When visual-analysis scores and response time were used as individual predictors, and analytic concepts on CST or error scores on MFF or DRT were the criterion, the multiple correlations were much higher than those obtained when only a single predictor was used.

Study 6

This study assessed the effect of impersonal versus reassuring testing conditions on the reflection-impulsivity dimension among third grade children. There was no consistent difference in errors or response time on three different tasks between *S*s examined under "cold versus warm" testing conditions. However, there was marked intraindividual consistency in response time and errors across the three tasks, supporting the generality of this cognitive disposition.

Study 7

A small group of Fels children (7–11 years of age) was administered a battery of tests including CST. The results supported the findings from Studies 1, 2, and 3, for analytic concepts were inversely correlated with the occurrence of incorrect hypotheses on perceptual discrimination tests.

Study 8

Several independent analyses assessed the relationship between analytic concepts on CST and the behavioral variables of task unrelated gross motor behavior and distractibility. In one study analytic concepts were positively correlated with the ratio of task attention to distractibility in the classroom. Moreover, analytic boys were less likely than nonanalytic boys to display bursts of gross motor behavior on a school playground. Further, production of analytic concepts was positively correlated with regularity of respiration under conditions of rest and during attention to simple stimuli. Finally, boys who were analytic, in contrast to nonanalytic *S*s, during the early school years were rated as less hyperkinetic and more involved in solitary task mastery during the first 8 years of life.

The accumulated evidence suggests that reflection over alternative-solution possibilities and visual analysis are fundamental cognitive dispositions that influence both analytic concepts on CST and perceptual recognition errors on DRT or MFF. It was suggested that the determinants of these two dispositions may be related to constitutional variables, degree of involvement in the task, and anxiety over task competence.

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